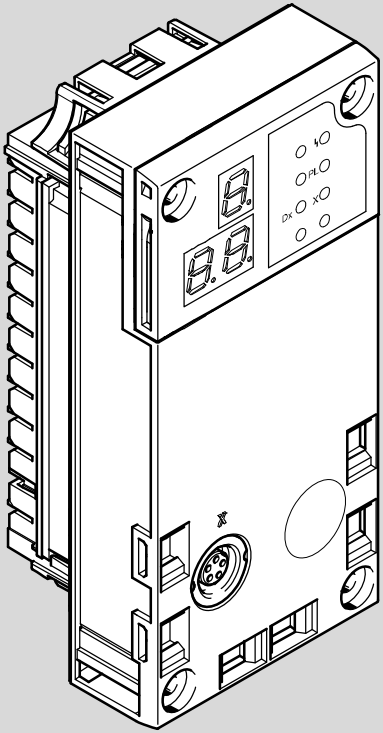
Terminal CPX

Axis controller CPX-CMAX



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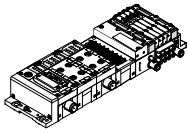
Communication profile description

FHPP for the CMAX axis controller

Activation and diagnostics via the CPX node

Type CPX-CMAX-C1-1



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Translation of the original instructions
P.BE-CPX-CMAX-CONTROL-EN

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Identification of hazards and instructions on how to prevent them:

Warning
Hazards that can cause death or serious injuries.

Caution
Hazards that can cause minor injuries or serious material damage.

Other symbols:

Note
Material damage or loss of function.

Recommendations, tips, references to other documentation.

Essential or useful accessories.

Information on environmentally sound usage.

Text designations:
- Activities that may be carried out in any order.
1. Activities that should be carried out in the order stated.
– General lists.
➔ Result of an action/References to more detailed information.

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Notes on this documentation

This description includes the communication profile for the axis controller CPX-CMAX-C1-1. The profile is based on the Festo Handling and Positioning Profile, in the following called “FHPP” for short. Included is information on control, diagnostics and parameterisation of the axis controller.

- Always observe the safety instructions given in the system description for CMAX (➔ Tab. 2). The system description also contains information on mounting, installation and diagnostics of the axis controller with the modules and components on the axis string.

Target group

This documentation is intended exclusively for technicians trained in control and automation technology, who have experience in installation, commissioning, programming and diagnostics of positioning systems.

Versions

This description refers to the following versions:
– axis controller CPX-CMAX-C1-1 with firmware version V 2.2.

Note

Before using a newer firmware version:

- Check whether a newer version of the FCT plug-in or user documentation is available: ➔ www.festo.com/sp, search term: CPX-CMAX-C1-1

Related firmware and plug-in versions

The CMAX firmware and the used plug-in version must always be compatible (status at the time of printing):

Firmware in the CMAX	Compatible FCT plug-in
2.2 (➔ Appendix A.5.1)	2.2.x (or higher)
1.9 (➔ Appendix A.5.2)	1.8.x (or higher)
1.8 (➔ Appendix A.5.3)	1.8.x (or higher)
1.1 (➔ Appendix A.5.4)	1.1.0 (or higher)
1.0 (➔ Appendix A.5.5)	1.0.1 (or higher)

Tab. 1 Compatibility and version overview

At a minimum, use the recommended compatible FCT plug-in for the firmware used. Further explanations ➔ Appendix A.6.

- Recommendation: Always install the newest plug-in version; this does not overwrite the older versions, which remain available.
- Inform service personnel and programmers about the plug-in and firmware design used. Label the CMAX correspondingly and, if needed, enclose the information on the firmware design included.

Service

Consult the regional Festo contact if you have technical problems.

Documentation for the CPX terminal

General basic information about the mode of operation, mounting, installation and commissioning of CPX terminals ➔ CPX system description, P.BE-CPX-SYS-...
(➔ www.festo.com/sp, search term CPX). Information about additional electronic modules from CPX ➔ Description on the respective electronics module. Overview of the structure of user documentation for the CPX terminal ➔ CPX system description.

Documentation for Axis controller CPX-CMAX

Type	Title	Order code	Contents
System description	Axis controller CPX-CMAX (description of electronics)	P.BE-CPX-CMAX-SYS-...	– Mounting – Installation – Commissioning – Diagnostics
Communication profile description	FHPP for the CPX-CMAX axis controller	P.BE-CPX-CMAX-CONTROL-...	– Control – Programming – Diagnostics of a CMAX with the used bus node
Software Help	Help for the Festo Configuration Tool (FCT) with CMAX plug-in		Configuration and commissioning of the CMAX axis controller with the FCT
Operating instructions	Operating instructions for the components used		

Tab. 2 Documentation for Axis controller CPX-CMAX

Electronic versions of the documentation for the CMAX axis controller as well as application notes for use of various CPX nodes are available in the Internet ➔ www.festo.com/sp, search term CPX-CMAX-C1-1

1 Configuration of the CPX terminal with the CMAX

1.1 Planning aspects regarding parameterisation of the CMAX

1.1.1 Notes on the available CPX bus nodes

Observe the list of approved CPX bus nodes (bus protocols) and control blocks and the required revisions in the system description for the CMAX.
With the Festo Field Device Tools, the firmware of many bus nodes can be checked and updated. The Festo Field Device Tool is available in the support portal
➔ www.festo.com/sp, search term “FFT”.
Current information is available in the catalogue ➔ www.festo.com/catalogue.
Observe the notes on the software status in the documentation for the bus node or control block.

General instructions on parameterisation of a bus node ➔ Description for the bus node used.

1.1.2 Parameters of the CMAX and parameters of the bus node

The CMAX has a number of module-specific parameters. These internal CMAX parameters cannot be stored as CPX module parameters in the bus node, but are saved exclusively in the CMAX.
It is therefore not possible to access the CMAX parameters in the usual way via the I/O diagnostic interface or through any corresponding specific channels of the bus node, but only through the service or network interface of the node with FCT or through the bus in the CMAX parameterisation operating mode.

Note
For CPX terminals with the CMAX, when replacing the complete CPX terminal or the CMAX module, it is always necessary to carry out parameterisation and commissioning of the CMAX again, since the parameters and data determined during commissioning are saved exclusively in the CMAX.

The internal CMAX parameters can be changed via the following access methods:
– Festo Configuration Tool (FCT) with CMAX plug-in,
– cyclical fieldbus communication with the control and status data of the FHPP (parameterisation operating mode) ➔ Sections 2.2.6 and 5.5,
– acyclic Fieldbus communication (e.g. PROFIBUS DPV1) ➔ Section 5.6 as well as in the Application Note ➔ www.festo.com/sp.

1.2 Data format

Multi-byte values are usually interpreted by CMAX in the byte sequence “INTEL (LSB-MSB)”.

INTEL (LSB-MSB) - Little Endian				
Example	$21\ 268\ 514_d = 01\ 44\ 88\ 22_h$			
Byte address	0	1	2	3
Bit no.	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
Bin	0 0 1 0 0 0 1 0	1 0 0 0 1 0 0 0	0 1 0 0 0 1 0 0	0 0 0 0 0 0 0 1
Hex	22h	88h	44h	01h

If the control system uses a different byte sequence, this must be taken into account correspondingly, e.g. in the application program.

CPX parameter “Analogue process value representation”

Some CPX bus nodes (e.g. CPX-FB13 FB33, FB34 and FB35) support the global system parameter “Analogue process value presentation” (system table function number 4402, bit 7):

– Value “0”: INTEL (LSB-MSB) – presetting
– Value “1”: MOTOROLA (MSB-LSB)

MOTOROLA (MSB-LSB) - Big Endian				
Example	$21\ 268\ 514_d = 01\ 44\ 88\ 22_h$			
Byte address	0	1	2	3
Bit no.	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
Bin	0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0	1 0 0 0 1 0 0 0	0 0 1 0 0 0 1 0
Hex	01h	44h	88h	22h

The CMAX evaluates this global system parameter and converts the byte sequence accordingly. After changing the parameter, wait for about 2 seconds until the CMAX conversion has been reliably executed.

The CMAX exchanges the byte sequence, both in the cyclical (I/O data) as well as acyclical data (parameters).

1.3 CPX parameterisation

1.3.1 Fail state or idle mode

Depending on your application and the bus node used, check whether parameterisation of fail state or idle mode for the selected CMAX module has to be configured in the bus node.
The fail state or idle mode allows creation of defined I/O statuses in the event of bus failure or activation of the idle mode of the CPX terminal. These functions are not available for all bus nodes.

Additional information on different CPX nodes in the respective Application Note in the support portal ➔ www.festo.com/sp.

1.3.2 Start-up behaviour of the CPX terminal

The desired parameterisation of the CPX terminal can normally be carried out in the start-up phase or after fieldbus interruptions by the bus controller or the scanner/bus master, providing this is supported by the fieldbus protocol used.

Note
When exchanging a CMAX, parameterisation is not automatically established over the bus node.
In this case, a correct parameterisation of the CMAX must always be performed just as with initial start-up ➔ Section 1.1.2.

Follow the notes for exchanging components in the CMAX system description.

1.4 Notes on commissioning via the higher-order controller

Fundamentally, the CMAX can be completely commissioned through the higher order controller or the controller integrated into the CPX node.
But this always requires additional programming and suitable measures for monitoring the drive while the commissioning operation is being executed.

Recommendation:
- Perform initial commissioning with the FCT.

Tab. 1.1 shows an overview of the necessary functions with references to detailed information, which must be observed during commissioning.

Function	Description	Topic	Information
Entire commissioning sequence	Preparations for commissioning and their step-by-step execution	Notes on commissioning, service and firmware	➔ Appendix A
During the entire commissioning process	Control and monitoring of CMAX	Control and status bytes	➔ Chapter 2
		Diagnostics	➔ Chapter 4
Parameterisation	Reading the detected actual configuration, writing the target configuration, parametrisation of the application data, etc.	Festo Parameter Channel FPC (Festo Parameter Channel)	➔ Section 5.4
		Parameterisation operating mode	➔ Section 5.5
Commissioning functions	Execution of commissioning operations, movement test, identification, teaching functions	Commissioning mode	➔ Section 2.2.5
		Commissioning operations	➔ Section 3.2

Tab. 1.1 Information on commissioning via the higher-order controller

Also follow the instructions in the CMAX system description (chapter “Commissioning”).

2 I/O data and sequence control

2.1 Operating modes

The CMAX recognises 4 operating modes. These differ in content and structure from the cyclical I/O data of the CMAX.

2.1.1 Record selection operating mode – record mode

The CMAX has 64 records, which contain all the necessary information for a movement command.
A record must be parameterised in advance, e.g. with FCT.
In record mode, the record number is transferred to the output data of the higher-order controller that the CMAX should execute with the next start. The input data include the record number that was processed last.
The CMAX does not include any user program. Records cannot be processed automatically with a programmable logic. The CMAX cannot be operated as stand-alone without a higher-order controller.
However, it is possible to link various records and execute them one after the other with the help of a start command. It is also possible to define a record sequencing before the target value (position or force) is reached.
In this way, positioning profiles can be created without any effect by the inactive times which arise from the transfer in the fieldbus and the controller's cycle time.

Detailed information on the record mode ➔ Section 3.3.
Overview of the I/O data ➔ Section 2.2.3.

2.1.2 Direct operating mode –direct mode

In the direct mode, movement commands (travel to position or set force) are formulated directly in the output data of the controller and transferred to the CMAX. The typical application dynamically calculates the new target value for each movement command. As a result, for example, adaptation to different workpiece sizes can be achieved more easily. In this operating mode, the target value (position or force) and alternatively the speed, the moved payload or the force ramp can be changed dynamically for each new movement command. The setpoint values are managed completely in the controller or calculated and sent directly to the CMAX.

Detailed information on the record mode ➔ Section 3.4.
Overview of the I/O data ➔ Section 2.2.4.

2.1.3 Commissioning operating mode

The commissioning operating mode is used to place the CMAX into operation, carrying out identification runs, for example, etc. The following functions are permitted:

– Parameterisation of all axis data (with the FCT or via the controller with the help of the FPC (Festo Parameter Channel)
– Jogging, teaching, referencing
– Movement test, identification, other commissioning operations

Movement commands (record mode, direct mode) are not permissible. This operating mode mainly serves to establish a clear separation between the commissioning operation and normal operation (movement commands in the record or direct mode) to minimise the risk of operational errors.

Information on the commissioning operations ➔ Section 3.2.
Overview of the I/O data ➔ Section 2.2.5.

2.1.4 Parameterisation operating mode

In parameterisation mode, parameters which are actually meant to control the CMAX can be transferred in the cyclical I/O data of the FHPP. Allocation of the first control bytes CCON for control of enabling and operating mode of the CMAX always remains the same. The seven other bytes are occupied by the Festo Parameter Channel (FPC).
Parameterisation mode can be activated in the states “Drive blocked” or “Drive enabled”. Accordingly, the controller is then active, or not. Similarly, an enable command might be present and so a vertical drive can be held in the current position.
A movement command cannot be started in this operating mode.

Information on parameterisation ➔ Chapter 5.
Overview of the I/O data ➔ Section 2.2.6.

2.1.5 Overview of the available functions in the operating modes

Function	Operating mode			
	Record mode	Direct mode	Commis-sioning	Parame-terisation
Parameterisation in the cyclical I/O data[1)]				x
Acyclical parameterisation of axis data[2)]			x	
Acyclical parameterisation of setpoint values	x	x	x	
Jogging	x	x	x	
Teaching of setpoint values	x			
Teaching of project zero point, software end positions			x	
Homing	x	x	x	
Point-to-point positioning	x	x		
Positioning continuously, tracking mode		x		
Force controls, point to point	x	x		
On-the-fly setpoint value switching (new movement command before MC)	x	x		
Identification			x	
Movement test			x	

1) Only permissible with CCON.STOP = 0, for some parameters also CCON.ENABLE = 0

2) Only permissible for CCON.ENABLE = 0

Tab. 2.1 Available functions in the operating modes

Description of the drive functions ➔ Chapter 3.

2.2 Structure of the cyclical I/O data in the operating modes

Data	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Output data	CCON	CPOS	Control bytes dependent on operating modes					
Input data	SCON	SPOS	Status bytes dependent on operating modes					
Function	Byte 1 remains in its function in every operating mode. It includes control and status information, such as for enabling and adjustment of the operating mode. Byte 2 is identical for the record selection, direct and commissioning operating modes.		Bytes 3 to 8 depend on the selected operating mode and transmit additional control and status bytes (e.g. CDIR, SDIR, ...) as well as setpoint and actual values: – Record number or setpoint position in the output data – Feedback of actual position and record number in the input data – Additional setpoint and actual values dependent on the operating mode and regulation mode With PNU 523, the content of bytes 3 to 8 can be partially configured.					

Procedure

First determine the operating mode in the control byte CCON ➔ Sections 2.2.1 and 2.2.2.

This results in the assignment of the other control and status bytes:

– Record mode ➔ Section 2.2.3
– Direct mode ➔ Section 2.2.4
– Commissioning ➔ Section 2.2.5
– Parameterisation ➔ Section 2.2.6

Recommendation:

- During operation (record or direct operating mode), set the control bit CCON.LOCK. This lets the higher-order controller ensure that the programmed sequence cannot be disrupted through accidental access with the FCT.
- Evaluate status bit SCON.FCT. Consider the missing control access in the program sequence of the controller.

2.2.1 Defining the operating mode with CCON

The operating mode is determined through the control bytes CCON.OPM1 and CCON.OPM2 and is acknowledged in the status bytes SCON.OPM1 and SCON.OPM2 (➔ Tab. 2.2).

Operating mode	CCON/SCON		Description
	.OPM2	.OPM1	
Record mode	0	0	The higher-order controller selects a record from a record table saved in the CMAX. A record contains all the parameters which are specified for a movement command. The record number is transferred to the cyclical I/O data as setpoint and actual value.
Direct mode	0	1	The movement command is transferred directly to the cyclical I/O data. The most important setpoint values (position, speed, force) are transferred here. Supplementary parameters (e.g. acceleration) are defined by the parameterisation.
Commissioning	1	0	Commissioning operations (e.g. identification) can be executed. A travel command (positioning or force command) is not possible.
Parameterisation	1	1	A parameter is transferred in the I/O data according to the FPC protocol. A travel command (positioning or force command) is not possible.

Tab. 2.2 Overview of CMAX operating modes

Switching the operating mode

Switching the operating mode to Commissioning or Parameterisation is only allowed in the status "Drive blocked" (CCON.ENABLE = 0) or "Drive enabled" (CCON.STOP = 0). Switching between record mode and direct mode is additionally permitted for the status "Ready" if MC is present (SPOS.MC = 1). The operating mode can also be switched if there is an "Error" status.

During switching of the operating mode, the meaning of the setpoint and actual values in bytes 2 ... 8 in the higher-order controller and the CMAX do **not** agree. And so at **every** switchover, the feedback of the switchover **must** be awaited before the next command can be executed. This also applies for switching between direct mode and record mode.

Recommendation: During switchover of the operating mode, always set all setpoint value bytes 2 ... 8 to 0 to avoid faulty setpoint values in the next travel command.

Flow chart for programming the higher-order controller ➔ Appendix A.4.4.

Note on time behaviour

The switchover between record and direct mode is made in the CPX system (CPX node and CMAX) typically within 5 to 10 msec. Added to this are the bus transmission time and the cycle time of the controller. This change-over time must be taken into account in programming the application.

2.2.2 CCON/SCON structure

CCON

All the statuses which must be available in all operating modes are controlled with control byte 1 (CCON).

Assignment of the CCON control byte (byte 1)

CCON	B7 OPM2	B6 OPM1	B5 LOCK	B4 –	B3 RESET	B2 BRAKE	B1 STOP	B0 ENABLE
	Operating mode 2	Operating mode 1	Block FCT access	–	Acknow-ledge error	Release brake	Enable operation	Enable drive

SCON

The status byte 1 (SCON) signals the CMAX status in all operating modes.

Assignment of the SCON control byte (byte 1)

SCON	B7 OPM2	B6 OPM1	B5 FCT	B4 24VL	B3 FAULT	B2 WARN	B1 READY	B0 ENABLED
	Operating mode 2	Operating mode 1	FCT device control	Load voltage	Fault	Warning	Operation enabled	Drive enabled

The operating mode is defined with CCON.OPM1 and OPM2 and is acknowledged in SCON.OPM1 and OPM2.

How the control bits work together can be found in the sequence control description ➔ Chapter 3.
Flow charts for programming the higher-order controller ➔ Appendix A.4.

Control byte 1 (CCON)

Bit	DE	EN	Description
B0 **ENABLE**	Enable drive	**Enable** Drive	= 0: Block drive = 1: Enable drive, the controller is activated (“close loop control activated”)
B1 **STOP**	Enable operation	Enable Operation	= 0: Activate stop (cancel stop + travel command), ➔ Section 3.1.4 = 1: Enable operation, no **stop**. Not permitted in parameterisation operating mode. A warning is signaled in parameterisation mode if logic 1 is set.
B2 **Brake**	Release brake	Open **Brake**	= 0: Activate clamping unit/brake (0 V at output VPWP) = 1: Release clamping unit/brake (24 V at output VPWP) ➔ Section 3.1.7
B3 **RESET**	Acknowledge error	**Reset** Fault	With a **rising edge**, an error message present is deleted and, if successful, the “Error” status is exited. Flow chart for programming the higher-order controller ➔ Appendix A.4.3.
B4 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B5 **LOCK**	Block FCT access	**Lock** FCT Access	Access to the service or network interface: = 0: FCT can transfer device control (to change parameters or control inputs). = 1: FCT may only observe, transfer of device control (FCT) not possible.
B6 **OPM1** **B7** **OPM2**	Operating mode 1/2	**Op**erating **M**ode 1/2	**Bit 7** / **Bit 6** / **Selecting operating mode** 0 / 0 / Record mode ➔ Section 2.2.3 0 / 1 / Direct mode ➔ Section 2.2.4 1 / 0 / Commissioning ➔ Section 2.2.5 1 / 1 / Parameterisation ➔ Section 2.2.6

Status byte 1 (SCON)					
Bit	**DE**	**EN**	**Description**		
B0 **ENABLED**	Drive enabled	Drive **Enabled**	= 0: = 1:	Drive blocked, controller not active Drive enabled	
B1 **Ready**	Operation enabled	Operation Enabled	= 0: = 1:	Stop active Operation enabled, travel commands allowed (Drive is **READY**)	
B2 **WARN**	Warning	**Warn**ing	= 0: = 1:	Warning not present Warning present	
B3 **FAULT**	Fault	**Fault**	= 0: = 1:	No fault Fault is present	
B4 **24VL**	Load voltage	Load Voltage	= 0: = 1:	No load voltage Load voltage present (**24 V L**oad Voltage)	
B5 **FCT**	FCT device control	Device Control **FCT**	= 0: = 1:	Device control blocked over service or network interface Device control allowed over service or network interface (FCT)	
B6 **OPM1**	Operating mode 1/2	**Op**erating **M**ode 1/2	**Bit 7**	**Bit 6**	**Operating mode acknowledgement**
			0	0	Record mode
B7 **OPM2**			0	1	Direct mode
			1	0	Commissioning
			1	1	Parameterisation

2.2.3 I/O data in record mode

Flow chart for programming the higher-order controller ➔ Appendix A.4.2.

I/O data: record mode								
Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	CPOS	Record number	Reserved	Reserved			
Input data	SCON	SPOS	Record number	Secondary actual value	Primary actual value (actual position, actual force)			

Assignment of the control and status bytes (record select mode):

Assignment of the control bytes (record select mode)								
CCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Operating mode 1/2		Block FCT access	–	Acknowledge error	Release brake	Enable operation	Enable drive
CPOS Byte 2	**B7 –**	**B6 –**	**B5 TEACH**	**B4 JOGN**	**B3 JOGP**	**B2 HOM**	**B1 START**	**B0 –**
	–	–	Teach value	Jog negative	Jog positive	Start homing	Start movement command	–
Record number Byte 3	Byte 3: Record number of the record to be started (1 ... 64).							
Reserved Byte 4	Reserved = 0							
Reserved Byte 5...8	Reserved = 0							

Assignment of the status bytes (record select mode)								
SCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 FCT**	**B4 24VL**	**B3 FAULT**	**B2 WARN**	**B1 READY**	**B0 ENABLED**
	Operating mode 1/2		FCT device control	Load voltage	Fault	Warning	Operation enabled	Drive enabled
SPOS Byte 2	**B7 REF**	**B6 STILL**	**B5 DEV**	**B4 MOV**	**B3 TEACH**	**B2 MC**	**B1 ACK**	**B0 –**
	Drive referenced	Standstill warning	Following error	Axis is moving	Acknowledge teach	Motion complete	Acknowledge start	–
Record number Byte 3	Feedback of last started record (1 ... 64). With record sequencing, the actual record number always contains the record number currently being executed, so it changes without a starting edge during record continuation.							
Secondary actual value Byte 4	Depending on the parameterisation (PNU 523:03/07): – RSB (see below for assignment) – current error number							
	Assignment of record status byte (RSB)							
	B7 –	**B6 –**	**B5 XLIM**	**B4 VLIM**	**B3 RCE**	**B2 COM1**	**B1 RCC**	**B0 RC1**
	–	–	Critical stroke reached	Critical speed reached	Fault in record continuation	Control mode 1	All records complete	1st record complete
Primary actual value Byte 5...8	Depending on the parameterisation (PNU 523:04/08): – Actual position in the established system of measurement units ➔ Appendix B.1 – Actual force in the established system of measurement units ➔ Appendix B.1 – Combined actual force and actual position with adjusted scaling ➔ Tab. 2.3 Force control and display of force/torque values is not supported for semi-rotary drives.							

System of units	**Cylinder diameter**	**Assignment of status bytes 5 ... 8 / range of values**			
		Byte 5	Byte 6	Byte 7	Byte 8
Metric SI	Øeff ≤ 160 mm	Actual force [N]		Actual position [0.1 mm]	
		-32,768 N ... +32,767 N		-3,276.8 mm ... +3,276.7 mm	
	Øeff › 160 mm	Actual force [10 N]		Actual position [0.1 mm]	
		-327,680 N ... +322,670 N		-3,276.8 mm ... +3,226.7 mm	
Imperial	Independent of the diameter	Actual force [lbf]		Actual position [0.01 in]	
		-32,768 lbf ... +32,767 lbf		-327.68 in ... +327.67 in	

Tab. 2.3 Assignment of primary actual value “Combined actual force and actual position”

Control byte 2 (CPOS) – record mode			
Bit	**DE**	**EN**	**Description**
B0 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B1 **START**	Start movement command	**Start** Movement Command	The current record number is taken over and the record started through a **rising edge**.
B2 **HOM**	Start homing	Start **Hom**ing	With a **rising edge**, homing is started with the set parameters. Referencing is reset. A fault is reported with an absolute measuring system.
B3 **JOGP**	Jog positive	**Jog P**ositive	The drive moves at the specified speed in the direction of larger actual values, providing the bit is set.
B4 **JOGN**	Jog negative	**Jog N**egative	The drive moves at the specified speed in the direction of smaller values, providing the bit is set.
B5 **TEACH**	Teach value	**Teach** Value	With a **falling edge**, the current actual value is transferred to the nominal value register of the currently addressed record. With a **rising edge**: Prepare teaching (transfer record number teach target).
B6 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B7 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.

Control byte 2 (CPOS) controls the positioning sequences as soon as the drive has been enabled.

Status byte 2 (SPOS) – record select mode			
Bit	**DE**	**EN**	**Description**
B0 **–**	–	–	Reserved (= 0)
B1 **ACK**	Acknowledge start	**Ack**nowledge Start	= 0: Ready for start = 1: Start carried out[1)]
B2 **MC**	Motion complete	**M**otion **C**omplete	= 0: Movement command active = 1: Movement command completed (also for error)[2)]
B3 **TEACH**	Acknowledge teach	Acknowledge **Teach**	= 0: Teach executed, actual value transferred = 1: Ready for teaching
B4 **MOV**	Drive moves	Drive is **mov**ing	Movement monitoring (➔ Section 3.1.9) = 0: Drive does not move = 1: Drive moves
B5 **DEV**	Following error	**Dev**iation Warning	Following error or tolerance monitoring (➔ Section 3.1.9) = 0: No following error / within tolerance = 1: Following error active / tolerance exited
B6 **STILL**	Standstill warning	Stand**still** Warning	Standstill monitoring (➔ Section 3.1.9) = 0: Standstill warning not active = 1: Standstill warning active, drive has moved after MC
B7 **REF**	Drive referenced	Drive is **ref**erenced	= 0: Homing must be carried out = 1: Reference information available, homing not necessary

1) When programming the handshake between CPOS.START and SPOS.ACK, the faults present must always be taken into consideration as well, since SPOS.ACK is not set in the event of a fault.

2) MC is set after device is switched on (status “Drive blocked”).

Status byte 4 (RSB) – record mode			
Bit	**DE**	**EN**	**Description**
B0 **RC1**	1st record complete	**1st Rec**ord complete[1)]	If at least one step enabling criterion has been configured: = 0: The first step enabling criterion has not yet been achieved. = 1: The first continuation has been carried out.
B1 **RCC**	All records complete	All **Rec**ords **C**omplete[1)]	If at least one step enabling criterion has been configured and motion complete (SPOS.MC) is present: = 0: Step enabling condition not met, record sequencing cancelled. = 1: Record sequencing was processed to the end.
B2 **COM1**	Control mode 1	**Co**ntrol **M**ode **1**	Feedback on control mode 1: = 0: Position control active = 1: Force control active
B3 **RCE**	Error in record sequencing	**Rec**ord Sequencing **E**rror[1)]	If at least one step enabling criterion has been configured: = 0: No error in record sequencing = 1: Record sequencing not carried out, cancelled, error reported
B4 **VLIM**	Critical speed reached	Critical velocity reached	Only with force control: = 0: Critical speed not reached = 1: Critical speed (**V**-**Lim**it) reached, error reported
B5 **XLIM**	Critical stroke reached	Critical stroke reached	Only with force control: = 0: Critical stroke not reached = 1: Critical stroke reached (**X**-**Lim**it), error reported
B6 **–**	–	–	Reserved
B7 **–**	–	–	Reserved

1) Record sequencing

The RSB status byte acknowledges the movement command in record mode.
If no other parameterisation was made with PNU523:03/07, the RSB record status byte is transferred as byte 4 in the record mode. All bits are reset at the start and are updated dynamically.

2.2.4 I/O data with direct mode

I/O data: direct mode								
Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	CPOS	CDIR	Secondary setpoint	Primary setpoint value (Setpoint position, setpoint force)			
Input data	SCON	SPOS	SDIR	Secondary actual value	Primary actual value (Actual position, actual force)			

Assignment of the control and status bytes (direct mode):

Assignment of the control bytes (direct mode)								
CCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Operating mode 1/2		Block FCT access	–	Acknowledge error	Release brake	Enable operation	Enable drive
CPOS Byte 2	**B7 –**	**B6 –**	**B5 TEACH**	**B4 JOGN**	**B3 JOGP**	**B2 HOM**	**B1 START**	**B0 –**
	–	–	Teach value	Jog negative	Jog positive	Start homing	Start movement command	–
CDIR Byte 3	**B7 –**	**B6 FAST**	**B5 XLIM**	**B4 VLIM**	**B3 CONT**	**B2 COM2**	**B1 COM1**	**B0 REL**
	–	Fast stop	Stroke monitoring deactivated	Speed monitoring deactivated	Tracking mode	Control mode 2 (profile)	Control mode 1 (position, force)	Setpoint value relative
Secondary setpoint value Byte 4	Dependent on the control mode (position/force) and parameterisation (PNU 523:01/05): – Position control: Speed as percentage of the base value (PNU 600 or 540) – Force control: Force ramp as a percentage of the base value (PNU 608 or 550) – Position/force control: Payload as a percentage of the base value (PNU 605 or 544 or PNU 551) Value range 0 ... 100, with no mathematical sign. Impermissible setpoint values are limited. With the secondary setpoint value “payload”, 100 % of the base value is always used for the speed or force ramp. The setpoint value is transferred with a rising edge at CPOS.START.							
Primary setpoint value Byte 5...8	Dependent on control mode (position/force): – Position control: position in the established system of measurement units (➔ Appendix B.1) – Force control: Force in the established system of measurement units (➔ Appendix B.1) The setpoint value is transferred with a rising edge at CPOS.START. In tracking mode, the nominal position is transferred continuously after the start until the end of tracking mode.							

Assignment of the status bytes (direct mode)

SCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 FCT**	**B4 24VL**	**B3 FAULT**	**B2 WARN**	**B1 READY**	**B0 ENABLED**
	Operating mode 1/2		FCT device control	Load voltage	Fault	Warning	Operation enabled	Drive enabled
SPOS Byte 2	**B7 REF**	**B6 STILL**	**B5 DEV**	**B4 MOV**	**B3 TEACH**	**B2 MC**	**B1 ACK**	**B0 –**
	Drive referenced	Standstill warning	Following error	Drive moves	Acknowledge teach	Motion complete	Acknowledge start	–
SDIR Byte 3	**B7 –**	**B6 FAST**[1)]	**B5 XLIM**	**B4 VLIM**	**B3 CONT**	**B2 COM2**	**B1 COM1**	**B0 REL**[1)]
	–	Fast stop	Critical stroke reached	Critical speed reached	Tracking mode	Control mode 2	Control mode 1	Setpoint value relative
Secondary actual value Byte 4	Depending on the parameterisation (PNU 523:03/07): – actual speed as a percentage of the base value (PNU 600 or 540) – current error number The secondary actual value for speed has a mathematical sign, so positive and negative values can be displayed. The entire value range is utilised, i.e. the displayed speed lies in the range from -128 % to +127 %. Higher speeds are limited to -128 % or +127 %.							
Primary actual value Byte 5...8	Depending on the parameterisation (PNU 523:04/08): – actual position in the established system of measurement units (➔ Appendix B.1) – actual force in the established system of measurement units (➔ Appendix B.1) – combined actual force and actual position with adjusted scaling (➔ Tab. 2.3 in Section 2.2.3 record mode)							

1) The status bits REL and FAST only change when the movement command is transferred (starting edge). All other status bits in the SDIR are updated dynamically.

Control byte 2 (CPOS) – direct mode			
Bit	**DE**	**EN**	**Description**
B0 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B1 **START**	Start movement command	**Start** Movement Command	With a **rising edge**, the current setpoint data are accepted and a movement command started.
B2 **HOM**	Start homing	Start **Hom**ing	With a **rising edge**, homing is started with the set parameters. Referencing is reset. A fault is reported with an absolute measuring system.
B3 **JOGP**	Jog positive	**Jog P**ositive	The drive moves at the specified speed in the direction of larger actual values, providing the bit is set.
B4 **JOGN**	Jog negative	**Jog N**egative	The drive moves at the specified speed in the direction of smaller values, providing the bit is set.
B5 **TEACH**	Teach value	**Teach** Value	Reserved (in direct mode). With logic 1, an error is signaled.
B6 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B7 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.

Control byte 2 (CPOS) controls the positioning sequences as soon as the drive has been enabled.

Control byte 3 (CDIR) – direct mode			
Bit	**DE**	**EN**	**Description**
B0 **REL**	Setpoint value relative	Set-point **Rel**ative	= 0: Setpoint value is absolute (for position control, with respect to the project zero point) = 1: Setpoint value is relative to the last setpoint/ actual value[1)]
B1 **COM1**	Control mode 1	**Co**ntrol **M**ode 1	= 0: Position control = 1: Force control
B2 **COM2**	Control mode 2	**Co**ntrol **M**ode 2	For position control only (COM1=0): = 0: Free profile: Speed and acceleration are freely specified = 1: Auto profile: Speed and acceleration are specified by the controller[2)] A fault is signaled for logic 1 with control mode force control.
B3 **CONT**	Tracking mode	Tracking Mode	For position control: Activates tracking mode (continuous setpoint value specification, **Cont**inuous mode): = 0: Do not activate tracking mode = 1: Activate tracking mode
B4 **VLIM**	Deactivate speed monitoring	Deactivate velocity monitoring	For force control: = 0: Activate monitoring of critical speed (**V**elocity **Lim**it) = 1: Deactivate monitoring of critical speed
B5 **XLIM**	Deactivate stroke monitoring	Deactivate stroke monitoring	For force control: = 0: Activate critical stroke monitoring (**X**-**Lim**it) = 1: Deactivate critical stroke monitoring
B6 **FAST**	Fast stop	**Fast** Stop	Regulation for setting MC upon reaching target value (quality class ➔ Section 3.1.6)[3)] = 0: Exact stop = 1: Fast stop
B7 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.

1) Position control: Setpoint value is relative to the last setpoint value (with MC) or to the actual value (if MC is not present). Force control ➔ Section 3.1.2.

2) Speed and acceleration are chosen by the controller as appropriate to the identification function, so that the target position is reached as quickly as possible and without overswing.

3) SPOS.MC is only set when the movement command corresponding to the selected regulation is completed. In the event of a fast stop, the standstill monitoring is deactivated.

CDIR control byte 3 (CDIR) is a special control byte for the direct mode.

Status byte 2 (SPOS) – direct mode			
Bit	**DE**	**EN**	**Description**
B0 **–**	–	–	Reserved (= 0)
B1 **ACK**	Acknowledge start	**Ack**nowledge Start	= 0: Ready for start = 1: Start carried out[1)]
B2 **MC**	Motion complete	**M**otion **C**omplete	= 0: Movement command active = 1: Movement command completed (also for error)[2)]
B3 **TEACH**	Acknowledge teach	Acknowledge **Teach**	Reserved (= 0)
B4 **MOV**	Drive moves	Drive is **mov**ing	Movement monitoring (➔ Section 3.1.9) = 0: Drive does not move = 1: Drive moves
B5 **DEV**	Following error	**Dev**iation Warning	Following error or tolerance monitoring (➔ Section 3.1.9) = 0: No following error / within tolerance = 1: Following error active / tolerance exited
B6 **STILL**	Standstill warning	Stand**still** Warning	Standstill monitoring (➔ Section 3.1.9) = 0: Standstill warning not active = 1: Standstill warning active, drive has moved after MC
B7 **Ref**	Drive referenced	Drive is **ref**erenced	= 0: Homing must be carried out = 1: Reference information available, homing not necessary

1) When programming the handshake between CPOS.START and SPOS.ACK, the faults present must always be taken into consideration as well, since SPOS.ACK might not be set in the event of a fault.

2) MC is set after device is switched on (status “Drive blocked”).

Status byte 3 (SDIR) – direct mode			
Bit	**DE**	**EN**	**Description**
B0 **REL**	Relative	**Rel**ative	= 0: Setpoint value is absolute = 1: Setpoint value is relative to the last setpoint value
B1 **COM1**	Control mode 1	**Co**ntrol **M**ode **1**	Control mode acknowledgment: = 0: Position control active = 1: Force control active
B2 **COM2**	Control mode 1	**Co**ntrol **M**ode **2**	Control mode acknowledgment, only with position control (COM1=0): = 0: Free profile = 1: Auto-profile
B3 **CONT**	Tracking mode	Tracking mode	Feedback on tracking mode (continuous setpoint value specification, **Cont**inuous mode): = 0: Tracking mode not active = 1: Tracking mode active
B4 **VLIM**	Critical speed reached	Critical velocity reached (**V**-**Lim**it)	Only with force control: = 0: Critical speed not reached = 1: Critical speed reached, error reported
B5 **XLIM**	Critical stroke reached	Critical stroke reached (**X**-**Lim**it)	Only with force control: = 0: Critical stroke not reached = 1: Critical stroke reached, error reported
B6 **FAST**	Fast stop	**Fast** stop	= 0: Exact stop is active = 1: Fast stop is active, error signaled
B7 **–**	–	–	Reserved (= 0)

The SDIR status byte is the acknowledgement of the movement command in direct mode.
The status bits REL and FAST only change when the movement command is transferred (starting edge).
All other status bits in the SDIR are updated dynamically.

2.2.5 I/O data in commissioning mode

I/O data: commissioning								
Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	CPOS	Function	Parameter 1	Parameter 2 (e.g. current payload)			
Input data	SCON	SPOS	Function	Secondary actual value	Primary actual value (actual position, actual force)			

Assignment of the control and status bytes (commissioning):

Assignment of the control bytes (commissioning)								
CCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Operating mode 1/2		Block FCT access	–	Acknowledge error	Release brake	Stop	Enable drive
CPOS Byte 2	**B7 –**	**B6 –**	**B5 TEACH**	**B4 JOGN**	**B3 JOGP**	**B2 HOM**	**B1 START**	**B0 –**
	–	–	Teach value	Jog negative	Jog positive	Start homing	Start movement command	–

Function byte 3	The function number selects the commissioning function to be started in Commissioning operating mode. The functions are executed with a rising edge at CPOS.START.				
	Value	**Function**	**Description**	**Param. 1**	**Param. 2**
	0	Reserved	Not permissible	–	–
	1	Identification	Execute identification travel	= 0	Payload
	2	Movement test	Execute movement test	= 0	= 0
	3 ... 255	Reserved	Not permissible	–	–
	The CMAX reports an error when reserved functions are executed.				
Parameter 1 Byte 4	When executing a commissioning operation: Reserved = 0. When teaching: teach target (➔ Section 3.2.6) A zero (0=) must be transferred in setpoint value bytes which are not used.				
Parameter 2 Byte 5...8	For “Identification” commissioning function only: current payload in the established system of measurement units (➔ Appendix B.1). A zero (0=) must be transferred in setpoint value bytes which are not used.				

Assignment of the status bytes (commissioning mode)

SCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 FCT**	**B4 24VL**	**B3 FAULT**	**B2 WARN**	**B1 READY**	**B0 ENABLED**
	Operating mode 1/2		FCT device control	Load voltage	Fault	Warning	Operation enabled	Drive enabled
SPOS Byte 2	**B7 REF**	**B6 STILL**	**B5 DEV**	**B4 MOV**	**B3 TEACH**	**B2 MC**	**B1 ACK**	**B0 –**
	Drive referenced	Standstill warning	Following error	Drive moves	Acknowledge teach	Motion complete	Acknowledge start	–
Function Byte 3	Depending on the parameterisation (PNU 523:03/07): – Feedback on the commissioning function currently being executed. – For configuration of the secondary actual value as an error number: progress display or teach target. The commissioning function is then not acknowledged.							
Secondary actual value Byte 4	Depending on the parameterisation (PNU 523:03/07): – Progress display or teach target When executing a commissioning operation: The progress display in the status data shows to what degree the function has progressed for long operations. Display in percent (0 % to 100 %). Jumps (e.g. from 24 % to 60 %) can occur in the progress display. If the function is aborted, the progress counter is set to 255 (0xFF). When teaching: teach target ➔ Section 3.2.6. – current error number							
Primary actual value Byte 5...8	Depending on the parameterisation (PNU 523:04/08): – Actual position in the established system of measurement units ➔ Appendix B.1 – Actual force in the established system of measurement units ➔ Appendix B.1 – combined actual force and actual position with adjusted scaling ➔ Tab. 2.3 in Section 2.2.3 record mode							

Control byte 2 (CPOS) – commissioning mode			
Bit	**DE**	**EN**	**Description**
B0 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B1 **Start**	Start movement command	**Start** Movement Command	With a **rising edge**, the current setpoint data are accepted and a movement command started.
B2 **HOM**	Start homing	Start **Hom**ing	With a **rising edge**, homing is started with the set parameters. Referencing is reset. A fault is reported with an absolute measuring system.
B3 **JOGP**	Jog positive	**Jog P**ositive	The drive moves at the specified speed in the direction of larger actual values, providing the bit is set.
B4 **JOGN**	Jog negative	**Jog N**egative	The drive moves at the specified speed in the direction of smaller values, providing the bit is set.
B5 **TEACH**	Teach value	**Teach** Actual Value	With a **falling edge**, the current actual value is transferred according to the teach function (teach target in parameter 1 ➔ Section 3.2.6). With **a rising edge**: Prepare teaching (transfer teach target).
B6 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.
B7 **–**	–	–	Reserved, must be 0. With logic 1, a warning is signaled.

Control byte 2 (CPOS) controls the movement commands as soon as the drive has been enabled.

Status byte 2 (SPOS) – commissioning mode			
Bit	**DE**	**EN**	**Description**
B0 **–**	–	–	Reserved (= 0)
B1 **ACK**	Acknowledge start	**Ack**nowledge Start	= 0: Ready for start = 1: Start carried out[1)]
B2 **MC**	Motion complete	**M**otion **C**omplete	= 0: Movement command active = 1: Movement command completed (also for error)[2)]
B3 **TEACH**	Acknowledge teach	Acknowledge **Teach**	= 0: Teach executed, actual value transferred = 1: Ready for teaching
B4 **MOV**	Drive moves	Drive is **mov**ing	Movement monitoring (➔ Section 3.1.9) = 0: Drive does not move = 1: Drive moves
B5 **DEV**	Following error	**Dev**iation Warning	Following error or tolerance monitoring (➔ Section 3.1.9) = 0: No following error / within tolerance = 1: Following error active / tolerance exited
B6 **STILL**	Standstill warning	Stand**still** Warning	Standstill monitoring (➔ Section 3.1.9) = 0: Standstill warning not active = 1: Standstill warning active, drive moved
B7 **Ref**	Drive referenced	Drive is **ref**erenced	= 0: Homing must be carried out = 1: Reference information available, homing not necessary

1) When programming the handshake between CPOS.START and SPOS.ACK, the faults present must always be taken into consideration as well, since SPOS.ACK might not be set in the event of a fault.

2) MC is set after device is switched on (status “Drive blocked”).

2.2.6 I/O data in parameterisation mode

I/O data: parameterisation								
Data	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	Sub-index	Task identifier + parameter number		Parameter value			
Input data	SCON	Sub-index	Reply identifier + parameter number		Parameter value			

Assignment of the control and status bytes (parameterisation):

Assignment of the control bytes (parameterisation)								
CCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 LOCK**	**B4 –**	**B3 RESET**	**B2 BRAKE**	**B1 STOP**	**B0 ENABLE**
	Operating mode 1/2		Block FCT access	–	Acknowledge error	Release brake	Enable operation	Enable drive
Sub-index Byte 2	Subindex of the parameter to be transferred.							
Parameter identifier byte 3+4	Job identifier and parameter number:							
	Bit	**Table of contents**	**Description**					
	0 ... 11	PNU	Parameter number of the parameter to be transferred					
	12 ... 15	ReqID	Task identifier, e.g. read, write (➔ Section 5.4.1)					
Parameter value Byte 5...8	Value of the parameter to be transferred. (32-bit number)							

Assignment of the status bytes (parameterisation)								
SCON Byte 1	**B7 OPM2**	**B6 OPM1**	**B5 FCT**	**B4 24VL**	**B3 FAULT**	**B2 WARN**	**B1 READY**	**B0 ENABLED**
	Operating mode 1/2		FCT device control	Load voltage	Fault	Warning	Operation enabled	Drive enabled
Sub-index Byte 2	Subindex of the transferred parameter.							
Parameter identifier byte 3+4	Reply identifier and parameter number:							
	Bit	**Table of contents**	**Description**					
	0 ... 11	PNU	Parameter number of the transferred parameter					
	12 ... 15	ResID	Response identifier (➔ Section 5.4.1)					
Parameter value Byte 5...8	Value of the parameter to be transferred. (32-bit number)							

2.3 Finite state machine FHPP

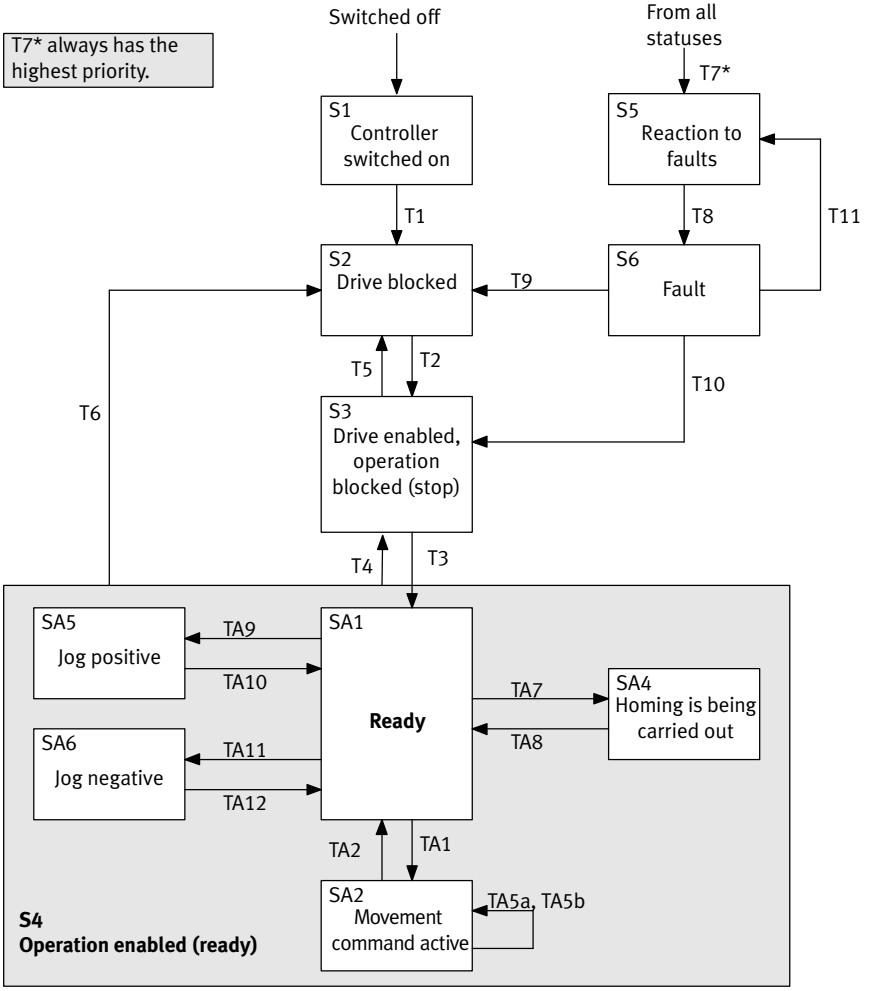


Fig. 2.1 Finite state machine

Notes on the "operation enabled" status

Transitions T4, T6 and T7* are executed from every sub-state SAx and automatically have a higher priority than any transition TAx.

Reaction to faults

T7 ("Fault recognised") has the highest priority (and is marked with an asterisk "*").

2.3.1 Establishing the ready status

T	Internal conditions	Actions of the user
T1	Drive is switched on. An error cannot be determined.	–
T2	Load voltage applied. Master control with higher-order controller.	“Enable drive” = 1 CCON = xxx0.xxx**1**
T3	–	“Stop” = 1 CCON = xxx0.xx**1**1
T4	–	“Stop” = 0 CCON = xxx0.xx**0**1
T5	–	“Enable drive” = 0 CCON = xxx0.xxx**0**
T6	–	“Enable drive” = 0 CCON = xxx0.xxx**0**
T7*	Fault identified.	–
T8	Reaction to fault complete, drive stopped (motion complete = 1).	–
T9	No more errors are present (F2).	“Acknowledge error” = 0 → 1 CCON = xxx0.**R**xxx
T10	No more errors are present (F1).	“Acknowledge error” = 0 → 1 CCON = xxx0.**R**xx1
T11	Error is still present.	“Acknowledge error” = 0 → 1 CCON = xxx0.**R**xx1
Key: R = rising edge (Rising edge), F = falling edge (Falling edge), x = any		

Tab. 2.4 Establish transitions to ready status

Parameterisation operating mode

The parameterisation operating mode is not used for carrying out movement commands, but only for transferring parameters. Transition T3 is not permissible. The drive, then, cannot switch to the S4 status.

Flow chart for programming the higher-order controller ➔ Appendix A.4.1.

2.3.2 Starting movement commands

Note: Additionally, CCON = xxx0.xx11 is always a requirement.

TA	Internal conditions	Actions of the user
TA1	Homing is present.	Start movement command = 0 → 1 CPOS = 00x0 00**R**0
TA2	Motion Complete = 1 The current record is completed. The next record is not processed automatically.	CPOS = 00xx xxx0
TA5a	Record mode: The current record is completed. The next record is processed automatically.	CPOS = 00xx xxx0 A start is not necessary.
TA5b	Record mode or direct mode.	CPOS = 00xx xx**R**0
TA7	Reference travel (only with incremental displacement encoder).	Start homing = 0 →⎍1 CPOS = 00x0 0**R**x0
TA8	Referencing finished.	–
TA9	–	Jog positive = 0 →⎍1 CPOS = 00x0 **R**xx0
TA10	–	Jog positive = 1 →⎍0 CPOS = 00xx **F**xx0
TA11	–	Jog negative = 0 →⎍1 CPOS = 00x**R** xxx0
TA12	–	Jog negative = 1 →⎍0 CPOS = 00x**F** xxx0
Key: R = rising edge (Rising edge), F = falling edge (Falling edge), x = any TA3, TA4 and TA6 are reserved for future extensions.		

Tab. 2.5 Transitions when starting movement commands

Flow chart for programming the higher-order controller ➔ Appendix A.4.2.

3 Drive functions

3.1 General functional description

3.1.1 Position control

The basis for control of the pneumatic axes is a model control path stored in the CMAX. This model assumes a pneumatic axis, which is constructed in accordance with regulations, e.g. with regard to:

– the compressed air provided
– the valve-cylinder combination used
– the permitted mass load
– tubing sizes and lengths, etc.

The basic parameters of this control path are:

– the axis and application data
– internal data determined through the identification (➔ 3.2.3) and adaptation (➔ 3.2.4)

General characteristics

The following generally applies for position control:

– Setpoint values are filtered (low-pass) to “smoothen” jump-like changes.
– Following error monitoring (signal, if following error is greater than the monitoring window).
– Monitoring of software end positions (end position limitation and error message).

Relative commands ➔ Section 3.1.3.
Stop behaviour ➔ Section 3.1.4.

Auto-profile – single value mode (point-to-point)

With the automatic profile, a movement command is executed with the maximum speed, acceleration and deceleration determined during identification.

A typical travel profile, dependent on cylinder (length, diameter), load and determined identification data shows ➔ Fig. 3.1.

Requirement: The dynamic identification has been carried out. Otherwise, the travel record will be executed with the defaults for the free profile and a warning message will be output.

Characteristics:

– fastest and simplest type of point-to-point positioning
– no specification of speed or acceleration values
– payload adjustable separately for each movement command.
– on-the-fly switching to a new movement command with free profile possible.

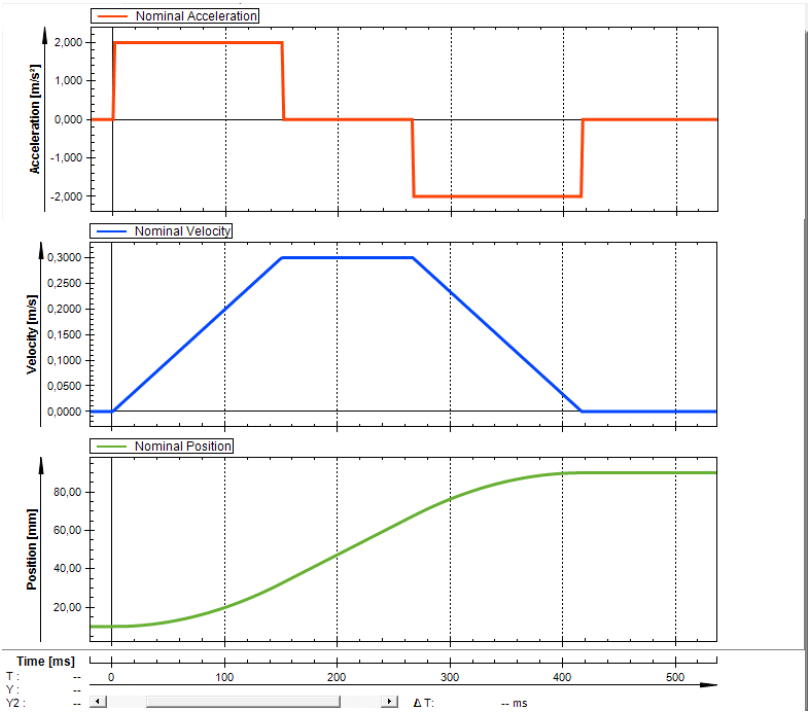


Fig. 3.1 Process of setpoint acceleration, setpoint speed and setpoint position with Auto Profile

Free profile – single value mode (point-to-point)

A movement command for a free profile is executed with the specified speed, acceleration and deceleration. If necessary, there is a limitation imposed on the values determined during identification.

A typical travel profile is shown in ➔ Fig. 3.2.

Characteristics:

– Speed, acceleration, deceleration and payload can be set separately for every position command.
– If the dynamic identification has been carried out: automatic limitation of acceleration to feasible values. Automatic limitation cannot be switched off.
– If dynamic identification has not been carried out: large divergence possible due to unachievable setpoint values. The optimal acceleration and deceleration values must be determined by the user.
– on-the-fly switching to a new position command possible.

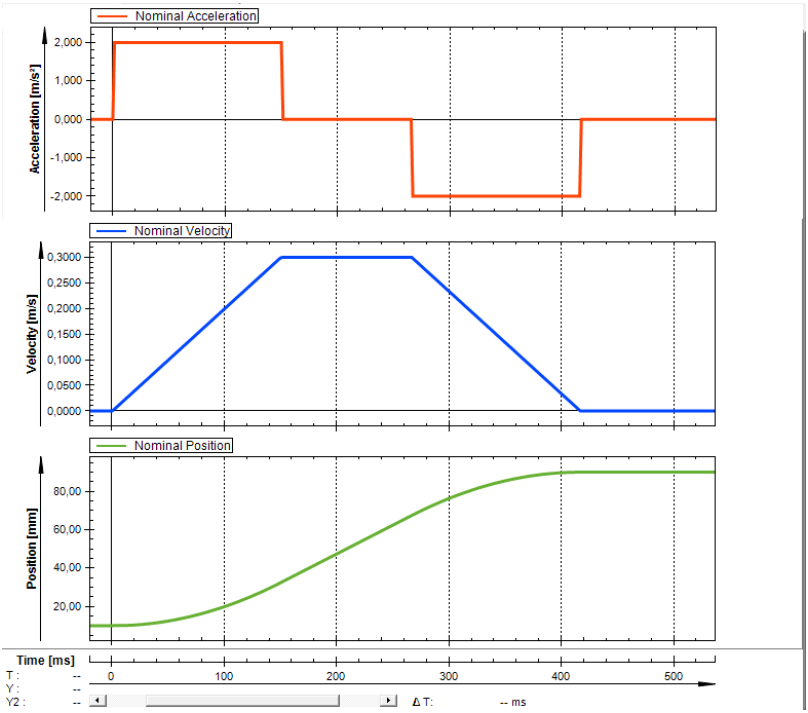


Fig. 3.2 Process of setpoint acceleration, setpoint speed and setpoint position with the free profile

Phase	Calculation equation	Description
Acceleration phase	$t_1 = \frac{v}{a_1}$	v = programmed speed a_1 = acceleration for acceleration ramp a_2 = acceleration for deceleration ramp t_1 = approach time t_2 = braking time t_3 = time with constant speed s_1 = approach path s_2 = braking path s_3 = path with constant speed s_{ges} = total path
	$s_1 = \frac{a_1}{2} \cdot t_1^2$	
Braking phase	$t_2 = \frac{v}{a_2}$	
	$s_2 = \frac{a_2}{2} \cdot t_2^2$	
Consistent movement	$s_3 = s_{ges}-(s_1 + s_2)$	
	$t_3 = \frac{s_3}{v}$	

Tab. 3.1 Calculation of the phases in the free profile

Continuous mode

In the case of continuous setpoint specification, an external position setpoint is tracked. The setpoint values are specified by a higher-order controller. Continuous setpoint specification (➔ 3.4.2) is only possible in direct mode and mainly corresponds to that of the free profile.

Characteristics:

– Speed, acceleration and deceleration are limited to values specified by the user (no automatic limitation).
– The payload can be set at the start of continuous positioning mode.

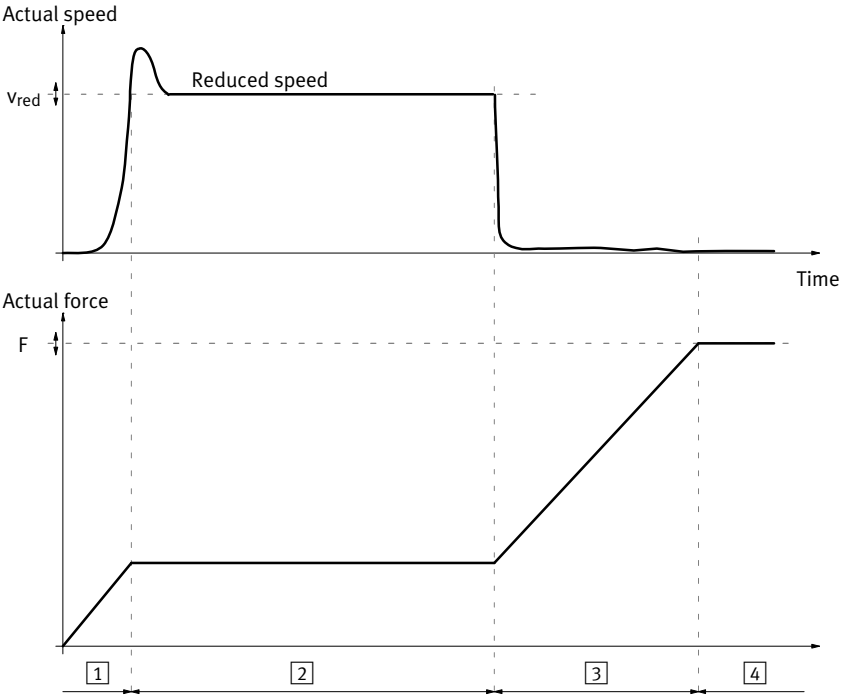
3.1.2 Force control

Force control of the cylinder is done by controlling the pressure forces which act on the piston in both cylinder chambers. It is not controlled directly; a force sensor on the workpiece would be required for this. The imprecision of the controlled force is therefore in the range of the static friction force of the drive. The target values are specified as a force in the system of units used. The force on the piston to be regulated is determined via the setpoint force, mounting position, base load and payload and the diameters of the piston and piston rod. The force controller is parameterised automatically dependent on the set project data. The control parameters can be optimised in individual cases ➔ Appendix B.5.3.
Main features:

- Target values and tolerance are specified as force.
- Force values have a sign (positive or negative).
  The sign of the force setpoint value determines the direction of force control:
  "+" means force build-up towards increasing position values
  "–" means force build-up towards decreasing position values
- monitoring of the software end positions and force limitations.
- adjustable setpoint force ramp (force increase per unit of time).
- path / speed monitoring during force control.
- travel at reduced speed if the counteracting force is missing.
- Given correctly specified total load and correctly configured mounting position, the target force and the reported actual force describe the effective force on the workpiece; see also below, "Influence of the total load on force control".
- Friction forces in the drive system (cylinder and guide) are not considered.
- Continuous setpoint tracking in force mode is not supported.

Force control sequence

If "Force control" is set as the control mode with a rising edge at CPOS.START in record mode or in direct mode, the CMAX interprets the target value specification as a force value. It activates the force control and adjusts the value with the set ramp.
Depending on the situation, force control takes place in various phases ➔ Fig. 3.3.



1 Start – force build-up with setpoint force ramp
2 Travel at reduced speed v_{red}
3 After reaching the workpiece, renewed force build-up with setpoint force ramp
4 Target force reached

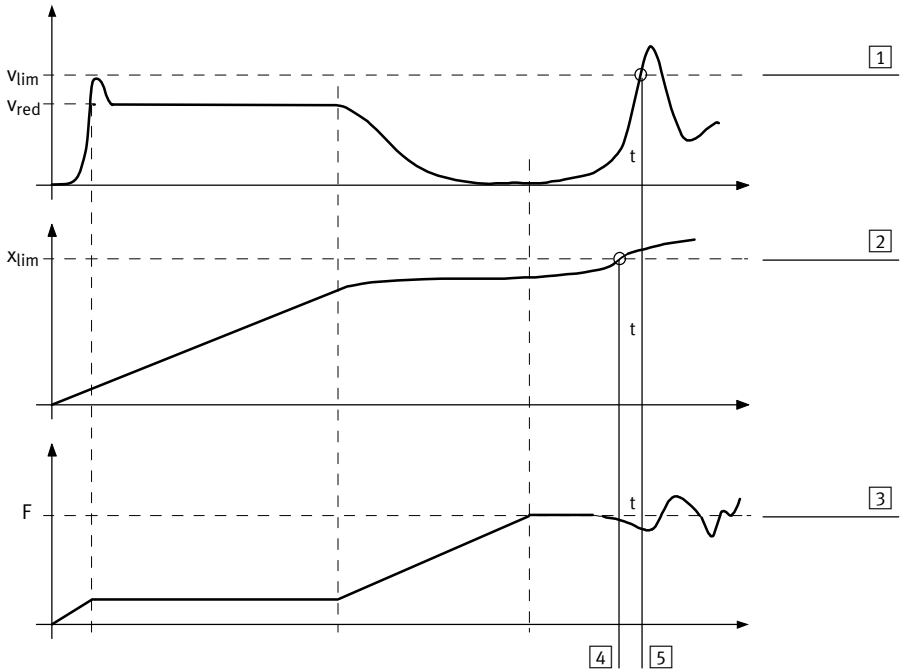
Fig. 3.3 Phases of the force control, schematic representation

1. The force command is triggered with the rising edge at CPOS.START. The MC signal jumps to “0”; the force build-up with the parameterised force ramp begins (phase 1).
2. Without sufficient counteracting force, the actual speed of the axis exceeds the value of the reduced speed v_{red}; the CMAX switches automatically into position control; and the axis travels further position-controlled at reduced speed. The axis is in phase 2, positioning travel with reduced speed v_{red}.
3. If the workpiece or the end stops are reached, the counteracting force rises. The CMAX recognises this (e.g. standstill), switches automatically back to force control and continues the force build-up with the force ramp. Phase 3 is run through.
4. If the actual force reaches the target force within the parameterised tolerance, MC is set and the force command is ended.
   The axis continues to press with the target force against the workpiece (phase 4). It remains in force control until a positioning command is started or a stop (➔ 3.1.4) carried out.

Further characteristics and notes:
- The parameterised setpoint force ramp is the averaged value of an in reality sin²-shaped scattered ramp. The maximum rise of this ramp is therefore twice as large as the specified average.
- The value of the reduced speed v_{red} is established with the following parameters.
  - Application data --› Specifications for force control --› Speed v_{red} (PNU 601)
  - Record table --› Movement command --› Speed v_{red} (PNU 406)
  - Direct mode --› Force control --› Speed v_{red} (PNU 554)
- The duration of the phase 2 (➔ Fig. 3.3) depends on how far the drive must travel after the start before it comes up against a sufficient counteracting force.
- after the start of a force command if the drive comes up against a sufficient counteracting force and switching to position control does not take place, there is no movement with reduced speed.
- The change to the position control 2 can be deliberately suppressed – deactivated – if the value of the reduced speed is set to “0”. In this case, the force build-up rises continuously with the setpoint force ramp until the target force is reached. That is the best method to achieve a fast, controlled force build-up, e.g. when pressing in workpieces. The requirement is that, prior to the force command, the drive has been positioned immediately in front of the workpiece to be pressed, i.e. is ‹ 1 mm in front of the press position.
- The stop behaviour of the drive described from the force control perspective ➔ Section 3.1.4.
- During change of force control back to position control, a stop (target position= actual position) is carried out first and then positioning takes place from the standstill.
- The target force may have the value 0 (no force, “forceless”). With horizontal configuration, the axis can then be freely moved through an external force, only against the friction of the system. This applies also for vertical configuration with correctly parameterised total load and completed static identification. The total load is balanced out.
- The CMAX also supports relative force commands (➔ Section 3.1.3).
- Force control outside the software end positions is not permitted and will lead to an error message.
- Optimisation of the controller data may be necessary with force control (➔ Section B.5.3).

Monitoring functions for force control

With active force control, if certain parameters are not observed, e.g. the expected workpiece is not present for pressing and the switchover to position control has been deactivated ($v_{red} = 0$), the drive can reach a very high speed and thereby travel unbraked into the end position. To prevent this situation, the CMAX has a speed and stroke monitoring function in the force control mode. Their limits – the critical speed and critical stroke – can be parameterised and both monitoring functions activated or deactivated independently of each other. Fig. 3.4 shows the relationships.



1 Critical speed v_{lim}
2 Critical stroke x_{lim}
3 Target force F
4 Example of limit violation during stroke monitoring
5 Example of limit violation during speed monitoring

Fig. 3.4 Monitoring function in force control, schematic representation

Notes regarding stroke and speed monitoring:

– At the start of the force command, the critical stroke XLIM is counted from the current position of the axis. The value is always positive (PNU 510).
  If the critical stroke is exceeded, RSB.XLIM or SDIR.XLIM (critical stroke reached) is set. The drive is stopped and SPOS.MC set as soon as the drive has stopped.
  An error message is generated and SCON.FAULT is set.
– The critical speed vlim is an absolute limit. The value is always positive. The selected value (PNU 511) should be oriented on the allowed maximum impact energy of the stops in the end positions. When the critical speed v_{lim} of more than 12 ms is exceeded, RSB.VLIM or SDIR.VLIM (critical speed reached) is set. The drive is stopped and SPOS.MC set as soon as the drive has stopped.
  An error message is generated and SCON.FAULT is set.
– Stroke and speed monitoring can be activated/deactivated independently of each other for each movement command (default: activated). The limits are global, i.e. apply for αall movement commands.

– If not blocked, stroke and speed monitoring is activated every time a force command is started.
– Stroke and speed monitoring is also active after MC until end of the force control, i.e. delayed limit value violations are recognised.
– The critical speed v_{lim} must always be parameterised clearly greater than the value of the reduced speed vred to avoid too early triggering of speed monitoring during the force command.
  Recommendation: $v_{lim} = (2 \ldots 3) * v_{red}$

Influence of the moving total load (base load + payload) on force control

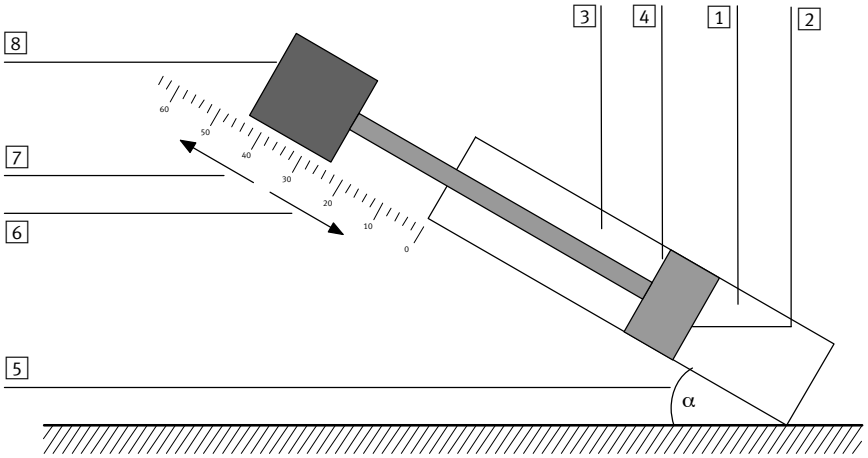
In the force control mode, the CMAX takes into account the effective gravitational force of the moved load on the drive. Fig. 3.5 shows the reference values of force control in a drive. The mathematic relationships listed in Tab. 3.2 apply. The force depends on the cylinder data and the controlled pressure values in both cylinder chambers. Additionally, the actual force is corrected by the effective gravitational force (= g * m * sin α).

Force during force control	
$F = p_1 * A_1 - p_2 * A_2 - g * m * \sin\alpha$	
P_1	Pressure in cylinder chamber 1: no piston rod, on measuring system zero point (smaller position values, blue connection)
P_2	Pressure in cylinder chamber 2, piston rod (if present), at the measuring system end (larger position values, black connection)
A_1, A_2	The two piston surfaces of the cylinder: The piston surfaces are calculated by the CMAX based on the cylinder type, cylinder diameter and piston rod diameter.
g	Acceleration due to gravity
m	Moving working load (base load + payload)
α	Angle of the mounting position of the axis

Tab. 3.2 Definition of the force for force control

The controlled force is the force at the piston minus the gravitational force of the moving total load.

Note:
The force arriving at the slide or the piston rod - that is, at the workpiece - deviates from the controlled actual force by the amount of the friction forces. The frictional force itself resists the direction of movement of the piston. Its value is added or subtracted from the actual force correspondingly.



Cylinder chamber 1:
1. Chamber pressure p_1
2. Piston surface A_1

Cylinder chamber 2:
3. Chamber pressure p_2
4. Piston surface A_2
5. Mounting position (α)
6. Position values become smaller, force values become smaller (sign –)
7. Position values become larger, force values become larger (sign +)
8. Moving total load

Fig. 3.5 Reference values for force control

The characteristic of gravitational force consideration can be used for weight compensation. If the target force F = 0 is set, the drive stops weight-compensated in the starting position at the start of the force command, provided that the total load and mounting position are correctly configured and a static identification has been carried out.

3.1.3 Relative commands

Relative commands are possible in record mode (control bit RCB1.REL = 1) and in the movement command in direct mode (control bit CDIR.REL = 1, status bit SDIR.REL = 1). In the case of continuous setpoint value in direct mode, a relative command is not allowed and leads to error E41.

Position control

Normally, the target value is relative to the last target value (for SPOS.MC=1) or the actual value (for SPOS.MC=0) at the start of the movement command.

Exceptions:

– For record sequencing, the relative target value refers to the preselected value if the condition has the same control mode (that is, for the conditions position, stroke, stroke after force, position after force).
– Positioning commands following force commands: during force control, the target position is always adjusted to the actual position. The relative target value thus refers to the actual position.
– For stop and enable, an internal target=actual comparison is executed. The relative target value then refers to this target value.

Force control

Normally, the target value is relative to the last target value (for SPOS.MC=1) or the actual value (for SPOS.MC=0) at the start of the movement command.

Exceptions:

– For record sequencing, the relative target value refers to the preselected value if the condition has the same control mode (that is, for the condition force).
– Force commands following positioning commands: Here the target force is set to 0 in the positioning control, that is, the relative target value refers to 0 for SPOS.MC = 1.
– Behaviour after stop and enable: Here the target force is likewise set to 0, that is, the relative target value refers to 0.

3.1.4 Stop behaviour

Position control

With position control, the The drive stops with the parameterised stop ramp; the positioning command is aborted and the standstill monitoring is deactivated.

If the delay valid in the current movement command is greater than the parameterised stop ramp, the delay of the current movement command results in a stop.

If stopping with the stop ramp or delay of the movement command is not possible (normally only for continuous positioning or record sequencing), setpoint position is set = actual position.

Force control

With force control, the drive first switches to position control, then brakes with maximum delay (determined internally) and then sets setpoint position = actual position.

3.1.5 Standstill control

Standstill control starts with ending of a movement command (MC).
There is a switch from position to force control to keep the drive safely at its standstill position. Here, the force currently applied to the piston is measured and is specified as a setpoint for the force control. So in contrast to force control, standstill control is not based on calculated values that are dependent on configured mass values, but on force values measured at the end of the positioning process. Mass changes that are not specified in the movement commands therefore do not affect the behaviour of the drive in the standstill position.
Due to pressure compensation operations, the force for the setpoint specification is not measured directly after the standstill condition has been reached, but:
– 200 ms later or
– when the change in the actual force exceeds a certain value (› 25 % of the frictional hysteresis).
The standstill condition has been reached if
– the tolerance has been reached once and
– the position error is within 120 % of the permissible tolerance window and
– the speed is less than 4 mm/s.
If the drive exits the tolerance window for the standstill condition while under standstill control, which can be caused by external forces, the position control is reactivated until the switching condition for the standstill control has been reached again.
Attention: When positioning, the drive comes to a standstill within the static friction, so the standstill force can also vary in the area of static friction. The force which is displayed at standstill therefore varies from stroke to stroke.

The standstill control can be switched off with PNU 1155 ➔ Section C.2.13.
In principle, the standstill control improves the standstill behaviour of the drive.
But in rare cases, e.g. with leakage or external forces, it can have an unfavourable effect on the positioning behaviour and can therefore be switched off.

3.1.6 Quality classes

The respective specific quality classes are used for positioning or force commands. As a result, conditions are defined with which a positioning command is signaled as being completed.

Quality class	Description
Exact stop	The movement command is completed when the drive is within the tolerance for the duration of the monitoring time (in the case of position control, it is nearly stopped – final speed check).
Fast stop	The movement command is completed as soon as the drive is within the tolerance.

Tab. 3.3 Quality classes

Motion complete (SPOS.MC) is only output if the record or movement command is completed according to the quality class ➔ Section 3.1.8.

3.1.7 Processing of the clamping unit or brake

On the VPWP, there is a digital output available for controlling a clamping unit or brake.

No clamping unit/brake configured

No clamping unit is configured in the factory settings (PNU 1143:03 = 0). The digital output on the VPWP always delivers 0 V.

Clamping unit/brake configured

If a clamping unit is configured (PNU 1143:03 = 1), the clamping unit is controlled exclusively by the control bit CCON.BRAKE, i.e. the clamping unit is always controlled only by the higher-order controller; the CMAX never switches the VPWP output by itself.

Note

For the CMAX to have the correct control function, the clamping unit or brake must always be switched with the following logic (➔ CMAX system description):

– Pin 2: 0 V = clamping unit/brake closed
– Pin 2: 24 V DC = clamping unit/brake open

CCON.BRAKE control logic

In the factory setting, the control logic is low active, i.e. the clamping unit/brake is closed for CCON.BRAKE = 0. The switching output on the VPWP delivers 0 V. With PNU 522:02, the control logic can be inverted (➔ Tab. 3.4).

CCON.BRAKE control logic	**Controller**	**VPWP**	**Clamping unit**
PNU 522:02	**CCON.BRAKE**	**Outlet**	**State**
Low active: = 0: Clamping unit/brake active for CCON.BRAKE = 0 (specification)	= 0	0 V	Closed
	= 1	24 V	Open
High active: = 1: Clamping unit/brake active for CCON.BRAKE = 1 (CMPX-compatible)	= 0	24 V	Open
	= 1	0 V	Closed

Tab. 3.4 CCON.BRAKE control logic

Note

The CMAX always sets the switching output on the valve to 0 V directly when the task for activating the clamping unit is detected (except if the drive is enabled at the same time, see below). The clamping unit/brake then becomes active directly, even if the drive is still moving or a force has built up.

- Check whether the clamping unit/brake allows the operating status.

Switch-on behaviour:

Since the clamping unit/brake is low-active by default, it is closed at switch-on (as long as CCON.BRAKE = 1 is set). If the clamping unit/brake is configured to be high-active,this remains closed until the first

trailing edge at CCON.BRAKE or the first drive enable. This prevents the clamping unit/brake from being released unintentionally, e.g. when all I/O data of the controller are set to 0 initially at switch-on.

Setting and releasing the clamping unit/brake

When the drive is disabled, setting and releasing the clamping unit/brake is transferred directly to the clamping unit/brake without any further CMAX reaction. If the drive is activated while the clamping unit/brake is closed, the CMAX goes over to force control with a force setpoint of 0 after enabling.

– To safely release the clamping unit/brake when an F2 error is present (SCON.FAULT=1, SCON.ENABLED = 0, SCON.READY=0), enabling must be reset (CCON.ENABLE=0).
– If there are communication malfunctions with the valve or the measurement system, it might not be possible to actuate the clamping unit/brake. Typically, these are the errors E43, E6x and E8x. If users want to be able to control the clamping unit/brake in these situations, too, they must actuate it through an independent channel and not with the CMAX.

After the clamping unit/brake is opened, a waiting time of 50 msec takes place, which the clamping unit/brake requires for mechanical opening. During this waiting period, SCON.READY = 0, even when operation enable is requested (CCON.STOP=1). A start is possible only after that ➔ Fig. 3.6.
If the controller is in the “Operation enabled” status (SCON. READY = 1), closing the clamping unit/brake has the same effect as resetting CCON.STOP. The “Operation enabled” status is exited with a stop, and SCON. READY = 0 is set. When standstill is reached, force control is activated with a force setpoint of 0.
It is not possible to close the clamping unit/brake and simultaneously remain in the “Operation enabled” status. If operation enable is requested (CCON.STOP= 1) while the clamping unit/brake is closed, the warning W18 is output. To prevent the warning, operation enable must be blocked (CCON.STOP=0) while the clamping unit/brake is being closed and the clamping unit/brake must be opened during granting of the operation enable.
In position control, standstill monitoring is active.

Note
The controller thereby takes the payload of the last movement command into account. If the mass specifications are incorrect (e.g. payload has changed), there could be compensating movements when the clamping unit/brake is released.

For vertical axes with clamping unit, note that mass variations of ± 30 % compared to the configured mass load can result in unexpected movement when the clamping unit is released despite the automatic weight compensation.
Remedy: Parameterise changed payload before release of the clamping unit/brake.
In the case of force control with non-horizontal mounting position, no compensation takes place.

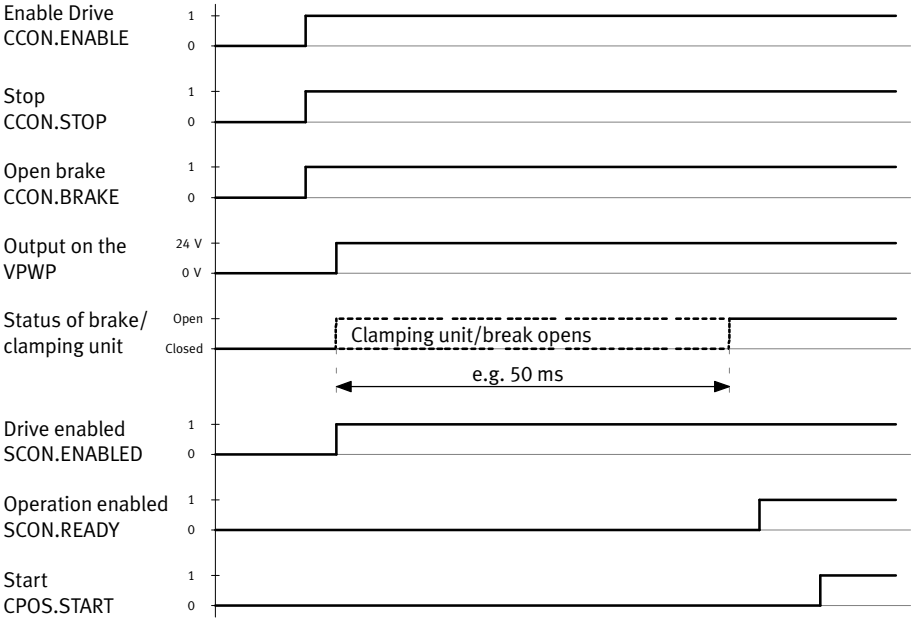


Fig. 3.6 Sequence, open clamping unit/brake

The real time for opening the clamping unit/brake is dependent on the mechanical inertia of the component used.

An overview of different cases for opening and closing the brake is shown in Tab. 3.5.

Status, action	**Sequence or status for ...**	
	Opening the clamping unit/brake	**Closing the clamping unit/brake**
Drive is blocked	Output VPWP (Pin 2) = 24 V	Output VPWP (Pin 2) = 0 V
Activate drive simultaneously	1. Output VPWP (Pin 2) = 24 V 2. Position control with setpoint = actual 3. SCON.ENABLED = 1	1. Position control with setpoint = actual 2. SCON.ENABLED = 1 3. Output VPWP (pin 2) = 0 V, simultaneously force control with 0 force
Drive is active	Output VPWP (pin 2) = 24 V, simultaneously switch from force control to position control with stop and setpoint-actual comparison	1. Output VPWP (pin 2) = 0 V, simultaneously stop with setpoint-actual comparison 2. Force control with 0 force
Block drive simultaneously	Output VPWP (pin 2) = 24 V, block drive simultaneously (SCON.ENABLED = 0)	1. Block drive (SCON.ENABLED = 0) 2. Output VPWP (Pin 2) = 0 V

Tab. 3.5 Behaviour when opening and closing the clamping unit/brake

An overview of different cases of enabling and blocking of the drive is shown in Tab. 3.6.

Status, action	**Sequence or status for ...**	
	Release of the drive	**Blocking of the drive**
Clamping unit/brake is closed	1. Position control with setpoint = actual 2. SCON.ENABLED = 1 3. Force control with 0 force	Block drive (SCON.ENABLED = 0)
Clamping unit/brake is open	1. Position control with setpoint = actual 2. SCON.ENABLED = 1	Block drive (SCON.ENABLED = 0)

Tab. 3.6 Behaviour when the drive is enabled and blocked

"Block drive" means either via the input data (CCON.ENABLE = 0) or CMAX-internal with an active error of level F2.

3.1.8 Motion Complete (MC)

Motion complete (SPOS.MC) defines whether a movement command is active. Motion complete rules:

- **MC = 0** is set at the start of a movement command **before SPOS.ACK** = 1 in case of:
  - movement command in record mode or direct mode (position or force control)
  - jogging
  - homing run
  - identification and movement test
- **MC = 0** is **not** set for:
  - stop
  - block drive
- **MC = 1** is set:
  - if the MC condition for the started movement command is met (compare this with the list of movement commands when setting MC = 0)
  - if the drive has been stopped or blocked and speed = 0 has been achieved
  - MC is set for the first time after switch-on (status “Drive blocked”).

  In the case of force control, the breakaway force can result in the MC condition possibly being met already at the beginning of the movement command. Here the criteria for the MC condition can be influenced via the parameters monitoring time, tolerance, etc.

Depending on the cycle time of the controller, SPOS.MC = 0 might not always be recognised (e.g. during positioning with fast stop at the actual position).
MC is valid from the time SPOS.ACK = 1 for the started movement command, even if no status change can be recognised in the controller.

Position control

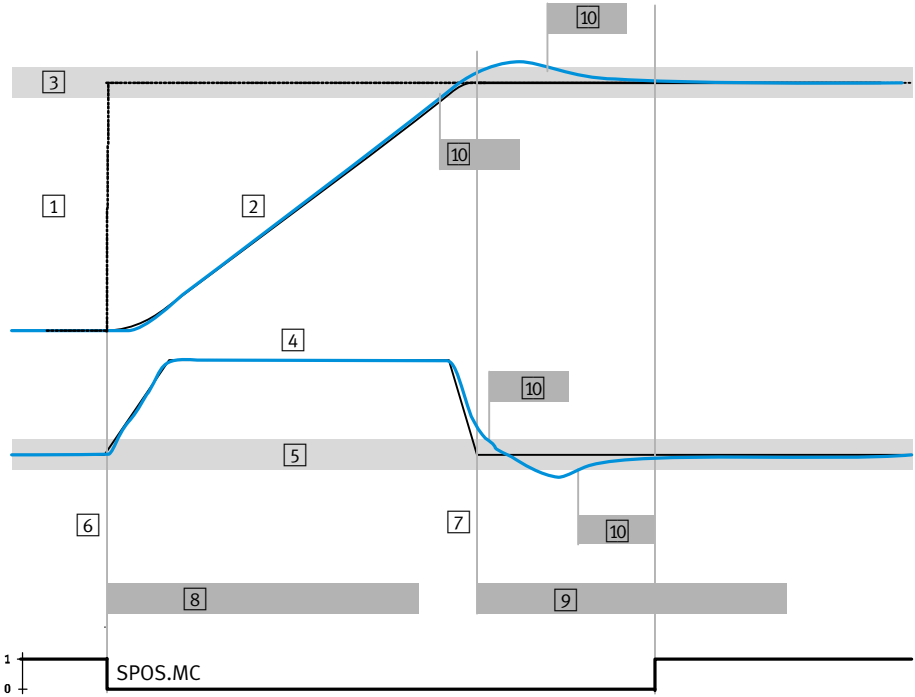
The Motion complete (SPOS.MC) signal indicates whether the last started movement command has been ended. It is made up of several logical conditions (➔ Tab. 3.7 and Fig. 3.7).

Condition	Description
Permanent entry in tolerance window for position	The actual position reaches the position tolerance window and does not exit it again during the set monitoring time. The monitoring time (PNU 1154) can be parameterised in expert mode with the FCT (controller data -› position controller). The position tolerance window corresponds to the target position ± the currently set position tolerance.
Permanent entry in tolerance window for speed	The actual speed reaches the speed tolerance window for rest and does not exit it again during the set monitoring time. The monitoring time is the same as for the position (PNU 1154). The tolerance window is equivalent to ± 4 mm/s (±0.16 ft/s; ±4°/s).
Starting timeout (error E31)	After the start of the setpoint curve, the axis must move at least 11 mm (0.43 in; 11°) within the timeout time (PNU 1153). Otherwise, the CMAX signals a starting timeout.

Condition	Description
Positioning timeout (error E30)	At the end of the setpoint curve, the position and speed conditions must be met. If one of the conditions is not met by the expiration of the timeout (PNU 1153), the CMAX signals a positioning timeout.

Tab. 3.7 Conditions for motion complete

For the quality class “Fast stop”, MC is set as soon as the actual position has reached the tolerance window position. The monitoring time is not waited and the speed condition is not taken into consideration. That means that the axis might still be moving when MC occurs. It is possible that the tolerance could be exited again.
Due to the fast stop, the positioning time is shortened accordingly (= time to MC). This is suitable for positions which do not require high precision.



1 Position target value
2 Setpoint value/actual value of position
3 Position tolerance window
4 Setpoint value/actual value of speed
5 Speed tolerance window for standstill
6 Start of the setpoint value curve
7 End of the setpoint value curve
8 1st timeout (start timeout)
9 2nd timeout (positioning timeout)
10 Monitoring time

Fig. 3.7 Motion complete (position control)

Force control

In the case of force control, the MC conditions correspond to those of position control, and correspondingly refer to the force setpoint value and force tolerance.

Special features:

– In the phase of position control with reduced speed, no MC is output (➔ Section 3.1.2). If the controller switches to position control with reduced speed only after MC=1, MC is not reset to 0.
– Timeout: PNU 1163
– Speed tolerance for rest is not monitored (e.g. the drive can move)
– no standstill warning
– no starting timeout (function is covered by pressure monitoring ➔ Error E50)

3.1.9 Dynamically updated controller status bits MOV, DEV and STILL

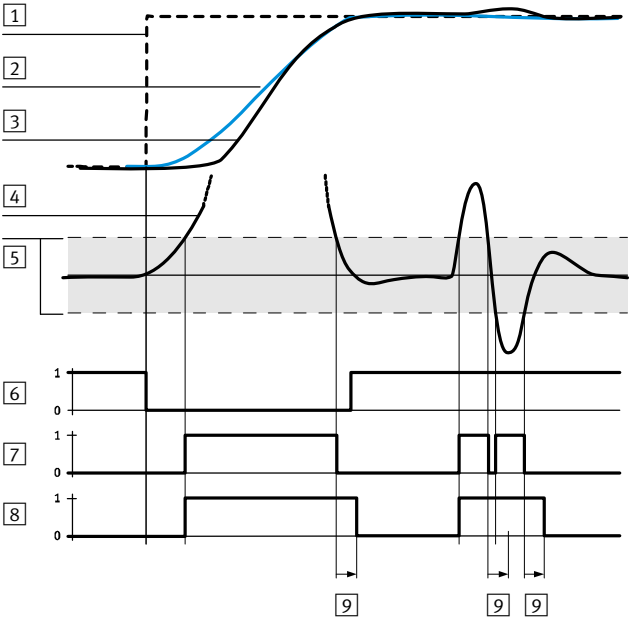
The status byte SPOS includes three controller status bits.

Bit	Description
SPOS.MOV	Axis is moving
SPOS.DEV	Following error / outside of tolerance
SPOS.STILL	Standstill warning

Tab. 3.8 Controller status bits

Movement monitoring (SPOS.MOV)

The bit SPOS.MOV indicates that the drive is moving. The CMAX checks whether the speed signal leaves an established speed tolerance window for rest. The internal status “Drive in motion” is additionally filtered with a switch-off time to simplify the evaluation in a controller program.



1 Target position
2 Setpoint position
3 Actual position
4 Actual speed
5 Speed tolerance window for standstill
6 Motion complete (SPOS.MC)
7 Internal status “Drive in motion”
8 Drive moves (SPOS.MOV)
9 Switch-off time T_{AUS}

Fig. 3.8 Movement monitoring

Overview of parameters involved

Parameters involved	Description	PNU
	Speed tolerance window for rest (fixed: ±4 mm/s; ±0.16 ft/s; ±4°/s)	–
	Switch-off time T_{AUS} (fixed: 30 ms)	–

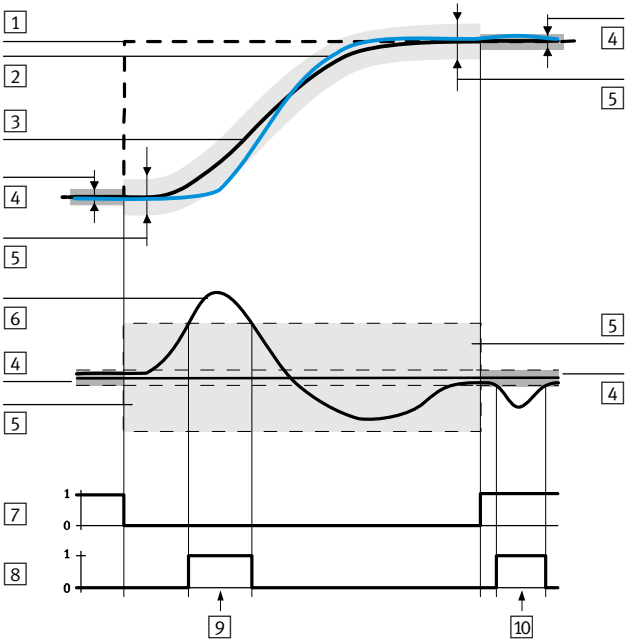
Tab. 3.9 Parameters involved in movement monitoring

Following error or tolerance monitoring (SPOS.DEV)

The bit SPOS.DEV (“Deviation” = following error) indicates that the control error (i.e. setpoint-actual value deviation) has exceeded a certain value. The permissible deviation depends on the movement status of the drive.

- Before reaching motion complete (SPOS.MC = 0)
  - During position control: following error, exiting the following error tolerance window of ±11 mm (±0.43 in; ±11°)
  - During force control: no monitoring (SPOS.DEV = 0)
- After reaching motion complete (SPOS.MC = 1): exit tolerance window (force or position). The tolerance window equals the target value ± the currently parameterised tolerance for the force or positioning command.

The following illustration shows the principle of following error or tolerance monitoring. The designation in the illustration refers to position control.



1	Target value	6	Control error
2	Setpoint value	7	Motion complete (SPOS.MC)
3	Actual value	8	Following error (SPOS.DEV)
4	Position tolerance window	9	Following error active
5	Following error tolerance window	10	Exit tolerance window

Explanation: 1 ... 3: Progression of setpoint value and actual value.
4 ... 6: Enlarged illustration of the control fault and the two tolerance windows.
7: The MC signal determines which tolerance is used.

Fig. 3.9 Following error or tolerance monitoring

Overview of parameters involved (➔ Section C.2)		
Parameters involved	**Description**	**PNU**
Position control	Target value: target position	300:02
	Setpoint value position	– [1)]
	Actual value: actual position	300:01
	Current position deviation	300:03
	Following error tolerance (fixed: 11 mm; 0.43 in; 11°)	–
	Position tolerance	606 / 411:xx or 545[2)]
Force control	Target value: target force	301:02
	Setpoint value force	– [1)]
	Actual value: actual force	301:01
	Current deviation, force	301:03
	Force tolerance	607 / 411:xx or 552[2)]

1) No parameter defined, but available in trace.

2) Depending on the parameterisation, the default value is used (➔ Section 5.3).

Tab. 3.10 Involved following error or tolerance monitoring parameters

Note: The following error tolerance is normally considerably larger than the position tolerance.

Standstill monitoring (SPOS.STILL)

The standstill warning bit indicates whether the drive has moved again since reaching motion complete.

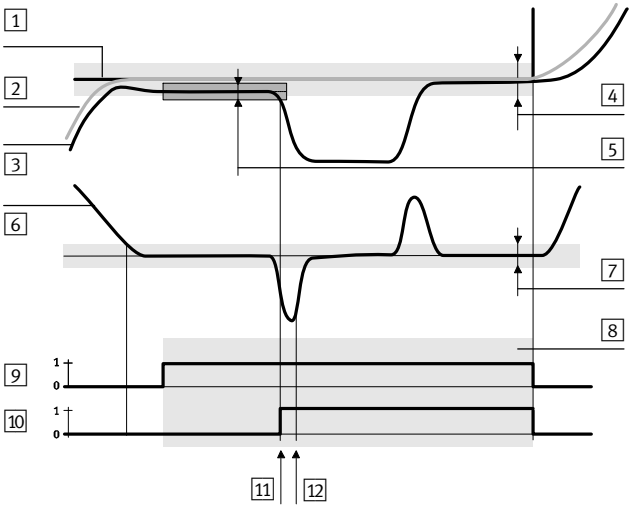
SPOS.STILL	Description
= 0	No movement
= 1	Warning: Drive has moved after MC. The bit remains set.

Tab. 3.11 Standstill monitoring statuses

Standstill monitoring is activated as soon as SPOS.MC = 1 is set. Standstill monitoring is only executed in the case of active position control and if valid reference information (SPOS.REF=1) is present.
In the case of homing, configured fast stop and stop, standstill monitoring is deactivated (i.e. a standstill warning is not issued even if the drive is still moving after MC).

The standstill warning is set if at least one of the following two conditions is met:
– The drive has left the speed tolerance window for rest (±4 mm/s; ±0.16 ft/s; ±4°/s) longer than a filter time TF of 30 ms. The filter time prevents the warning from being initiated due to noise, etc.
– The drive has left the standstill tolerance window. The standstill tolerance window is the position upon reaching the MC condition ± position tolerance, but at least ±0.1 mm (±0.004 in; ±0.1°). The drive may leave the actual position tolerance window (target position ± position tolerance).

A standstill warning is not entered in the diagnostic memory. The standstill warning bit is reset with the start of the next movement command or upon blocking of the controller.



1 Target position
2 Setpoint position
3 Actual position
4 Position tolerance window
5 Standstill tolerance window
6 Actual speed
7 Speed tolerance window for standstill
8 Standstill monitoring active
9 Motion complete (SPOS.MC)
10 Standstill warning (SPOS.STILL)
11 Position condition met: standstill tolerance exited
12 Speed condition met: drive moved for 30 ms

Fig. 3.10 Standstill monitoring

Overview of parameters involved (➔ Section C.2)		
Parameters involved	**Description**	**PNU**
	Current target position	300:02
	Actual position	300:01
	Position tolerance	606 / 411:xx or 545[1)]
	Standstill tolerance = 0.5 * position tolerance, at least 0.1 mm (0.004 in; 0.1°)	–
Start (FHPP)	SPOS.MC = rising edge: movement command completed	
Acknowledgement (FHPP)	SPOS.STILL = 1: Standstill warning active, drive has moved after MC	

1) Depending on the parameterisation, the default value is used (➔ Section 5.3).

Tab. 3.12 Parameters involved in standstill monitoring

3.1.10 Limitation of setpoint values

In order to position quickly without overshooting upon reaching the position or force setpoint value, CMAX limits setpoint values for accelerations and deceleration which are too high. During dynamic identification it is determined what maximum acceleration values allow for overshoot-free positioning. These values can lie below the physically achievable accelerations and decelerations, depending on the mass load, starting and target positions, etc. The setpoint values specified by the user for the speed and acceleration are limited to the maximum values determined independently by the CMAX during positioning.
The CMAX generates a data record during a movement command, which compares the user setpoints with the maximum values determined by the controller. In the FCT, the used values can be displayed in the “Limitation” tab. If dynamic identification is not carried out, the permissible limit values for the setpoint values must be determined by the user. By using these determined limits as setpoint values, overshoot-free positioning is guaranteed.

Position control

If a setpoint curve is generated based on acceleration setpoints which the drive cannot follow, this can lead to overshooting at the target position. With dynamic identification, the maximum attainable velocity as well as the acceleration ability and deceleration ability of the drive system are ascertained. With positioning, the aim is to facilitate overswing-free positioning behaviour.

Examples ➔ online help for the FCT plug-in CMAX, online tab “Limitation” (“Limits”).

Force control

The target force and force ramp are limited during force control. Analogously to position control, the start and target values are displayed on the FCT. The target value is always the target force. The starting value is the last setpoint value. If the position control was active, the last setpoint value is always 0 N. The starting and target positions are also valid, but are not displayed by the FCT. The actual position is used in this case.

Parameter for limiting values

The parameter for limiting values (PNU 1173) contains a structure with the values required for display. When the CMAX has determined values, it sets the “New values are present” bit in the status word.

3.2 Commissioning operations

3.2.1 Movement test

The movement test is for detecting defects in the tubing connection.
Recommendation: Execute movement test without payload.

Note
If the tubing connections of the VPWP get mixed up, the control direction is reversed. When activating the controller, the drive would move at maximum speed into the end position.

Carry out the movement test in the following cases:

- During commissioning after parameterisation.
  After parameterisation, the CMAX expects the movement test to be executed and indicates this by showing C03 on the display.
- When components are exchanged or the tubing connection has been disconnected and reconnected.

Special cases:

– If the movement test is to be skipped (not recommended), the status of the movement test must be set accordingly.
– The movement test status is automatically reset by the CMAX in the event of faults E01 and E08!
– If a movement test is to be carried out at a later time (e.g. after replacing hardware), the status of the movement test might have to be reset manually.

Carrying out the movement test

The movement test must be carried out without activating the controller. The valve is only controlled here. The valve control value is then calculated independently of any deviation. Instead, a chamber of the cylinder is deliberately pressurized until the drive moves. Based on the position change, the decision is made whether it moved in the correct direction.

1. To carry out the movement test, it must be enabled (CCON.ENABLE = 1, CCON.STOP =1). The “Status movement test” parameter (PNU 1174) contains a flag with bit 0 for the executed movement test. If Bit 0 has the value 0, the drive remains blocked (controller inactive) even if the CMAX is enabled. The CMAX still signals back the status “enabled”.
2. If a clamping unit is configured, it must be released before beginning the movement test.

Note

Especially with a vertical configuration, releasing the clamping unit with the controller deactivated can lead to the drive dropping down – directly after the start or also during the course of the movement test.

- Make sure that this does not pose a safety risk.
- Recommendation for vertical operation: Deliberately allow the drive to drop down to a stop or into the end position before starting the movement test.

3. With the rising edge at CPOS.START, the movement test is started when commissioning operation number 2 is registered. The two parameters must have the value 0 here. When another function or a positioning or force command is started, error E14 is signaled.
4. The CMAX then starts an internal sequence where the valve control values are directly specified and a corresponding evaluation is carried out based on the reaction of the drive. Finally, the result is stored in the “Status movement test” parameter. The end of the movement test is signaled with SPOS.MC = 1.

If the tubing connection is correct, the controller is enabled at the end of the movement test. Here, bit 0 in the movement test status is automatically set to 1 by the CMAX; the CMAX display changes to “000”. If the tubing connection is incorrect of if no clear result was determined, Bit 0 = 0; the controller is not enabled; and error message E13 or E15 is output.

PNU 1174: Status of movement test	
Bit	**Description**
0	= 0: Movement test must be carried out = 1: Movement test does not have to be carried out
1	= 0: Movement test has not been carried out = 1: Movement test has been carried out
2	= 0: Result of the movement test is not clear = 1: Result of the movement test is clear
3	= 0: Tubing connection error = 1: Tubing OK
4	= 0: Movement test was not skipped = 1: Movement test was skipped
5 ... 31	Not relevant (reserved)

Tab. 3.13 Status of movement test

The status of the movement test can be influenced by writing the commissioning operation parameter (PNU 1192:07):
= 1: Movement test is reset and must be carried out again.
= 2: Movement test is set to “does not have to be carried out” and is skipped.
The parameter can only be written when the CMAX is in commissioning mode and there is no enable.

Typical causes of error in application
– If Bit 0 in the “Movement test” parameter (PNU 1174) has the value 0, the CMAX can only execute a movement test. Every other movement command (e.g. identification, jogging, etc.) leads to an error.

Notes on correct tubing connection

Standardised setpoint specification	**Pressur-isation**	**Exhaust**	**Drive travels**
-100 %	1 --> 4	2 --> 3	... in the direction of smaller actual values
0 %	Closed	Closed	... not at all
+100 %	1 --> 2	4 --> 5	... in the direction of greater actual values

3.2.2 Homing

For drives with incremental measuring systems, homing is a prerequisite for a movement command.
Homing can be carried out in each supported operating mode except parameterisation.
The drive references with respect to a stop or, as a special case, the current position. Reaching the stop is detected when the piston comes to a standstill. Here, the possibility that this standstill was caused by a lack of air pressure must be ruled out.
Since the axis zero point for pneumatic axes must fundamentally be placed at the cylinder zero point, the drive does not automatically move to this zero point, unlike electric drives, for example.

Description of homing methods ➔ Tab. 3.15.

General instructions for homing

- The axes lose their reference:
  - when switched off/reset
  - possibly when there are errors in the sensor interface or axis string
  - when homing is started again
- If the drive has a position measuring system with an absolute encoder, homing is not possible.
  A rising edge at the CPOS.HOME input then results in an error. No movement is initiated.

Homing sequence and parameterisation

The drive references with respect to a stop (or the current actual position).
After the start of homing, the CMAX carries out the following steps:

1. Reset of the homing status to “Homing not executed”.
2. Search for the reference point (mechanical stop).
3. After standstill and a waiting period, the pressurized cylinder chamber must have a chamber pressure measuring at least 2/3 of the set operating pressure.
4. Determine the axis zero point/cylinder zero point by setting the corresponding offset to the reference point (➔ Section B.1).
5. After reaching the stop, the CMAX sets the status SPOS.REF = 1. The end of homing is signaled afterwards with SPOS.MC = 1.

Overview of parameters involved (➔ Section C.2.12)		
Parameters involved	**Description**	**PNU**
	Offset axis zero point	1130
	Homing method (permitted: -18, -17, 35)	1131
	Homing speed	1132
	Homing payload	1134
Start (FHPP)	CPOS.HOM = rising edge: Start homing, jogging has priority	
Acknowledgement (FHPP)	SPOS.ACK = rising edge: Acknowledge start SPOS.MC = 1: Movement completed SPOS.REF = 1: Drive referenced	

Tab. 3.14 Parameters involved in homing

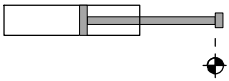
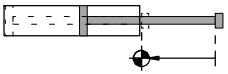
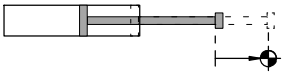
The setpoint values transmitted in the I/O data have no effect on homing.

The axis zero point offset has a great influence on CMAX controller optimisation. Even small values (a few mm) must be specified as exactly as possible:
– As offset, the distance between the stop used (reference point) and the cylinder end position (retracted piston rod) must be measured and entered as a negative value.
– When the piston rod is completely retracted (cylinder end position) the value 0 must be entered as offset.

Note
If the offset is imprecisely entered, the drive could end up vibrating strongly, depending on the setting of the involved parameters.
- Always carry out identification again after the offset has been corrected.

Homing methods

The homing methods are oriented on CiA 402 (device profile for electric drives ➔ www.can-cia.org).

Homing methods			
hex	**dec**	**Description**	
23 $_h$	35	**Current position** • The current position is taken as the reference position.	
EF_h	-17	**Negative stop** • Run at homing speed in negative direction to the stop. This position is taken as the homing point.	
EE_h	-18	**Positive stop** • Run at reference speed in positive direction to the stop. This position is taken as the homing point.	

Tab. 3.15 Overview of homing methods

3.2.3 Identification

During identification, mainly those path parameters are determined which are influenced by production fluctuations (e.g. valve covers, cylinder friction) or unknown installation factors (e.g. tubing connection, external friction), but the knowledge of which is important for the controller function.

For a good identification result, all parameters must be correctly set, especially the master data (base load, payload, supply pressure, ...), as well as the mechanical drive characteristics (especially the axis zero point offset).

- Repeat identification if one of these parameters changes during operation.

When does identification have to be carried out?

Identification is necessary during commissioning, when changing the current configuration data or when replacing certain components ➔ Appendix A.3.1. If the CMAX detects a corresponding change when comparing the setpoint with the actual configuration, a corresponding error message is generated and the controller is not activated.

The identification data do not necessary have to be reset, for example, after an error due to mixed up axis strings, the identification data can continue to be used after the strings are changed back.

– The CMAX signals a warning if identification should be carried out due to a change.
– The CMAX signals an error if identification must be carried out due to a change.
– The identification status parameter (PNU 1171) contains information about the identification status.

Static and dynamic identification

Static identification

With static identification, characteristics are ascertained which have an effect on the control behaviour of the system during positioning as well as on standstill control and the “0 force” in the force control. These include, among others, static friction of the drive and the valve characteristics in the mid-position range (small signal behaviour) of the valve hysteresis.

Dynamic identification

With dynamic identification, the acceleration ability and deceleration ability of the drive system is ascertained. The determined maximum values limit the setpoint acceleration and deceleration in positioning tasks to achievable values. This avoids following errors and the resultant overshooting of the target position. In the automatic profile, the CMAX always uses the determined maximum acceleration.
Dynamic identification must be carried out for axes which should move with automatic profile.
The dynamic part of the identification can be deactivated. This is important for cases where the structure cannot withstand dynamic stress. No maximum values for acceleration of the system are determined without the dynamic identification having been carried out. For position commands with “automatic profile”, a warning (W37) is then output and the movement command executed with “free profile” and the parameterised default values (PNU 600/602/603).
To avoid overshooting, users in this case must optimise the accelerations themselves. For different positioning strokes, different acceleration values might be necessary.
Dynamic identification has no influence on force control.

Identification sequence

The identification run consists of several steps:

1. Static identification
2. Dynamic identification (if configured)
3. If dynamic identification has been carried out:
   determination of average values for acceleration and deceleration in both directions for the free profile.

In static identification, the axis first moves to the middle of the setpoint stroke and carries out smaller movements in both directions. If the middle of the setpoint stroke cannot be approached due to the software end position, the CMAX moves close to the software end position in question at the start of static identification.

For optimal execution of dynamic identification, there should be as much free space as possible available for movement. The axis moves in the entire traversing range (effective stroke):

For drives with a cylinder length ‹ 100 mm, dynamic identification is not executed.

Executing identification

Requirement: Reference information present, SPOS.REF = 1.

1. Set commissioning operating mode.
2. Prepare identification:
   – Set commissioning operation 1.
   – Parameter 1 = 0
   – Parameter 2 = current payload in the system of measurement units
3. Start with rising edge at CPOS.START.
4. Wait for SPOS.MC = 1.
5. The CMAX enters the identification result in the identification status (PNU 1171).

PNU 1171: Identification status	
Bit	**Description**
0	= 0: Identification was not yet executed. = 1: Identification was executed at least once.
1	= 0: Static identification results are not available. = 1: Static identification executed successfully.
2	= 0: Dynamic identification results are not available. = 1: Dynamic identification executed successfully.
3 ... 31	Not relevant (reserved)

Tab. 3.16 Identification status

Notes:

– If large changes in the payload occur during operation, identification should be carried out with the largest and smallest payload that occurs.
– If the identification run is interrupted while in progress, static or dynamic identification data determined up to that point remain active.

Resetting identification

The identification data can be reset manually with PNU 1192:03 (➔ Section C.2.16).
The adaptation data are also reset.
Recommendation:
After exchanging components or changing parameters, the drive configuration (➔ C.2.11) or application settings (➔ C.2.12), the identification data should be reset before carrying out a new identification run.

3.2.4 Adaptation

After successful identification, the adaptation values are automatically determined during operation. Adaptation is able to independently improve non-optimal control behaviour. The reasons for poor control behaviour in small tolerance windows are long-term effects and imprecisely identified values. Adaptation affects position control, not force control.

Deactivating adaptation

Adaptation can be deactivated via the parameterisation. That is normally not required in any configuration. Only in extremely rare cases does adaptation lead to a deterioration of positioning behaviour. Important: Not every deterioration in the positioning behaviour is due to faulty adaptation. Wear or poor design can also cause, for example, positioning times to rise over time or even the frequency of the error message E30 to increase. For this reason, adaptation should only be deactivated in justified cases.

A faulty adaptation could be the reason for the following behaviour:

– After commissioning, the positioning behaviour deteriorates with time. Positioning times become longer, and the machine cycle becomes longer. E30 errors occur more often.
– After identification, the behaviour is significantly better without any other changes having been made. But then it slowly starts to worsen again until the next identification is performed.

A possible cause can be positioning against a non-uniform disturbing force.

In these cases, adaptation could be the cause of an increasing deterioration of the positioning behaviour.

If you think this is the case, you should deactivate adaptation and then re-run the identification. If the positioning behaviour no longer changes after this, adaptation was probably the cause and should remain deactivated.

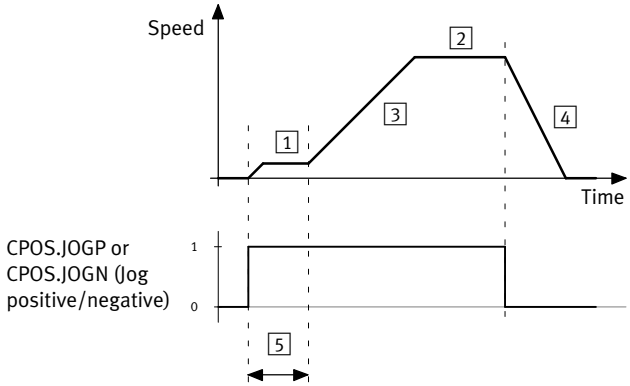
3.2.5 Jog operation

In the “Operation enabled” status, the drive can be traversed by jogging in the positive/negative directions. This function is usually used for:

– Moving to teach positions
– Running the drive out of the way (e.g. after a system malfunction)
– Manual travel as a normal operating mode (manually operated feed)

Process

1. With a rising edge on one of the signals Jog positive / Jog negative (CPOS.JOGP/CPOS.JOGN), the drive slowly starts to move (creeping phase). Due to the slow speed, a position can be travelled to very accurately.
2. If the signal remains set for longer than the configured creeping period, the speed is increased until the configured maximum speed is reached. In this way large strokes can be traversed quickly.
3. If the signal changes to 0, the drive will be braked with the maximum set deceleration.
4. The drive stops automatically if it reaches a software end position. The software end position is not passed; the travel for stopping is taken into account in accordance with the set ramp. Here, too, jog operation is only exited again after CPOS.JOGx = 0.



1 Creeping speed (slow travel)
2 Maximum speed
3 Acceleration
4 Deceleration
5 Duration of creeping phase

Fig. 3.11 Sequence chart for jog mode

Special operating statuses

– Before referencing, jogging is only possible at reference speed (PNU 1132).
– If the drive is outside the software end positions, jogging can be used to move it into the allowed range.
– If the drive is outside of the software end positions and is not in commissioning mode, the drive stops if it is to be moved further out by jogging. Error E33 is reported.
– If the software end positions are deactivated, the drive moves to the hardware end positions.

– In commissioning mode, the software end positions can be passed. Here, the drive first stops at the software end positions. Jogging must be restarted at the end position. Through the rising edge at CPOS.JOGx, the drive moves at creeping speed to the hardware end positions. As a result, for example, software end positions or the project zero point can be taught.
  Warning W35 is signaled when the software end positions are passed.
– CPOS.JOGN has priority. If JOGP and JOGN are set at the same time, travel is in the negative direction.

Timeout during jogging

The timeout during jogging is not caught, independent of the operating mode. If the axis is clamped and is not moving at all, error E31 (no movement after start) is generated.
If the CMAX determines that the axis came to a standstill before reaching the target position (or software end position/hardware end position), e.g. due to a stop or obstacle, error E30 (target position cannot be reached) is signaled.
Errors E31 or E30 can occur both during the creeping run as well as during the maximum speed phase. This is because CMAX executed two positioning commands internally. Since the drive can jog up to the hardware end position in commissioning mode, in principle the timeout here is possible. Jogging up to the hardware end position serves to teach the software end positions or the project zero point. Reaching the stop can very well be desired here.

Overview of parameters involved (➔ Section C.2)		
Parameters involved	**Description**	**PNU** [1]
	Jog mode, creeping speed[2]	530
	Jog mode, maximum speed[2]	531
	Jog mode acceleration	532
	Jog mode deceleration	533
	Jog mode, creeping period in ms	534
	Jog mode payload	536 / 605 [1]
Start (FHPP)	CPOS.JOGP = rising edge: Jog positive (direction of larger actual values) CPOS.JOGN = rising edge: Jog negative (direction of smaller actual values)	
Acknowledgement (FHPP)	SPOS.MOV = 1: Drive moves SPOS.MC = 0: Movement command active	

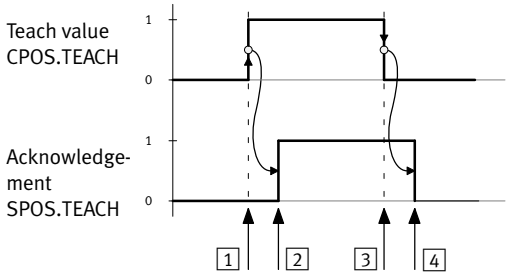
1) Depending on the parameterisation, the global default value is used (➔ Section 5.3).
2) The ratio of the speeds to one another is not limited. PNU 531 can be less than or equal to PNU 530.

Tab. 3.17 Parameters involved in jog mode

The setpoint values transmitted in the I/O data have no effect on jogging.

3.2.6 Teaching

The following values can be taught:
– setpoint values in the record table (record operation),
– project zero point and software end positions (commissioning).



1 Higher-order controller: Prepare teaching, transfer record number/teach target
2 CMAX: Ready for teaching
3 Higher-order controller: Teach now, transfer actual value
4 CMAX: Value transferred

Fig. 3.12 Handshake during teaching

Sequence of setpoint value in the record table

Position or force values can be taught. The existing setpoint values are overwritten here. The type is determined by the control mode in record control byte 1 (RCB1.COM1, RCB1.COM2).

1. Set record mode (CCON.OPM2 = 0 + CCON.OPM1 = 0).
   – The record number (controller output data, byte 3) must be set on the record which is to be taught. The record number is transferred with the rising edge to CPOS.TEACH.
   – If a force value is to be taught, the control mode must be set to “force” in record control byte 1 (RCB1.COM1 = 1 + RCB1.COM2 = 0).
2. Via jog mode, the drive is brought into the desired position by positioning or manually (by moving by hand in the “Drive blocked” status).
3. Teaching is carried out via the handshake of the bits CPOS.TEACH and SPOS.TEACH (➔ Fig. 3.12).

Notes:
– The drive does not have to stand still for teaching. However, a speed of 1 m/s means that the actual position changes by 1 mm every millisecond. With the usual cycle times of the higher-order controller + fieldbus + CMAX, this results in inaccuracies of several millimetres, even at a speed of only 0.1 m/s.
– It is still possible to teach the setpoint value if a record is blocked.
– If the setpoint value of a non-initialised record is taught, a corresponding new record is initialised and assigned default values. Here, the position is always taught.
– Only absolute setpoint values are taught. During teaching, bit RCB1.REL = 0 is therefore set in record control byte 1 of the taught record.

Project zero point and software end position sequence

These values can only be taught in “commissioning” mode. The higher-order controller must notify the CMAX of what is being taught in the setpoint parameter 1 (byte 4) as teach target

1. Set commissioning operating mode (CCON.OPM2 = 1 + CCON.OPM1 = 0).
2. The last commissioning operation (e.g. identification) must have been ended. Teaching is not permitted while a commissioning operation is active and will result in an error message.
3. Via jog mode, the drive is put into the desired position by positioning or manually (by moving by hand in “Drive blocked” status).
   Note: The software end positions may be passed during jogging. Outside of the software end positions, the drive only moves at creeping speed.
4. Enter the teach target in the output data of the controller; the function number (byte 3) is ignored.

I/O data: commissioning, teach function

Data	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Output data	CCON	CPOS	Function	Parameter 1: teach target	= 0			
Input data	SCON	SPOS	Function	Secondary actual value: teach target	Primary actual value			

Teach target (byte 4)

Value	Applies to PNU	Is taught
3	500:01	Project zero point
4	501:01	Lower software end position
5	501:02	Upper software end position

5. Teaching is carried out via the handshake of the bits CPOS.TEACH and SPOS.TEACH (➔ Fig. 3.12). Upon recognition, the valid teach target is reported in byte 4 of the input data (secondary actual value) with the rising edge at CPOS.TEACH. If the secondary actual value is configured as current error number (PNU 523:03/07), the teach target in byte 3 is reported (instead of the function).

Notes:
- The drive should be stopped during teaching.
- The signaled actual position changes suddenly when teaching the project zero point.
- As long as CPOS.TEACH = 1, the CMAX does not accept any starting edge. Therefore, no function can be started during teaching. Jogging is permissible, however.
- The acknowledgment of the teach target (byte 3 or byte 4 of the input data, see above) is reset in the case of:
  - rising edge at CPOS.TEACH
  - rising edge at CPOS.START
  - change in the operating mode (CCON.OPM1/CCON.OPM2)
- During teaching of the software end positions, make sure that the upper software end position is always larger than the lower one. If that is not the case, error E44 is signaled and the taught value is not accepted.
  Recommendation:
  First teach the upper and then the lower software end position. If no software end position has been taught yet, the lower software end position can also be taught first. The upper software end position is then automatically set to the upper hardware end position by the CMAX.

Typical errors and warnings during teaching

No.	Type	Cause
W35	Actual position is outside of the software end position	During teaching, a software end position has been passed.
E44	Teaching not possible	Teaching cannot be executed. Reasons: ➔ Section 4.2.4, causes for error E44. Additional information in the diagnostic memory ➔ Section 4.3.3.
E46	Start during teaching is not allowed	Commissioning mode: While CPOS.TEACH = 1, no commissioning operation can be started. Reason: Both the teaching function as well as the commissioning operation use parameter 1.

3.3 Record mode

A record can be started in the “Operation enabled” status. This function is usually used for:
– selection-free travel to records in the record table by the higher-order controller
– processing a positioning profile by linking records
– known target positions that seldom change (recipe change)

Regulating functions

Tab. 3.18 shows the supported controller functions in record mode.

Regulating function	is supported
Point-to-point (PTP) positioning	Yes
Positioning continuously, tracking mode	No
Force controls PTP (point to point)	Yes
Continuous force control	No
On-the-fly setpoint value switching (new movement command before MC)	Yes

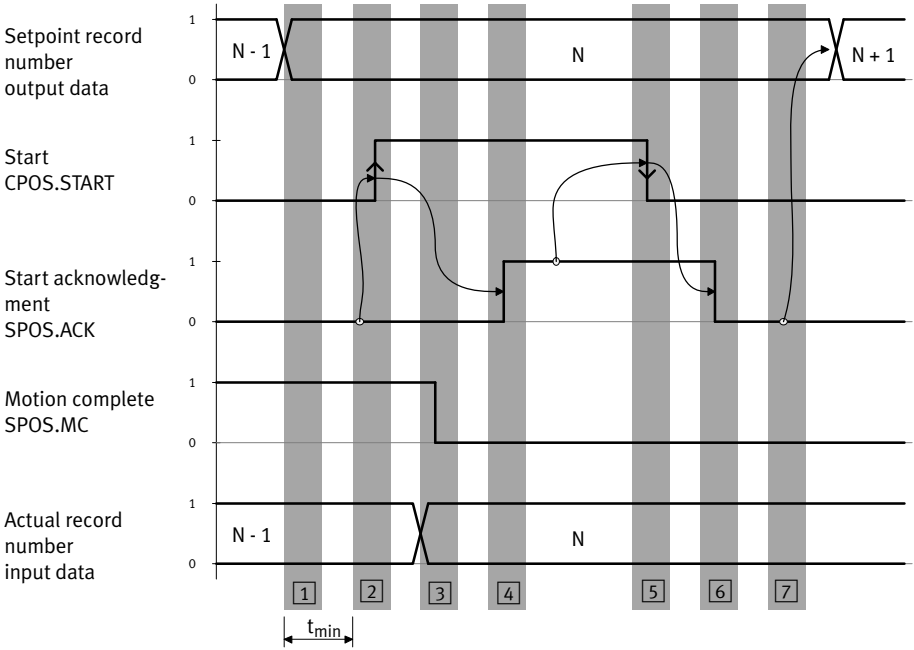
Tab. 3.18 Supported controller functions

Overview of parameters involved (➔ Section C.2)		
Parameters involved	**Description**	**PNU[1)]**
	All parameters of the record data (➔ Section 3.3.2, Tab. 3.20)	401 ... 412
	Default values, depending on PNU 403	600 ... 608
Start (FHPP)	CPOS.START = rising edge: Start Jogging and referencing have priority.	
Acknowledgement (FHPP)	SPOS.ACK = rising edge: Acknowledge start SPOS.MC = 0: Motion complete, movement command active	

1) Depending on the parameterisation, instead of the record data in PNU 406 ... 412, the global default values from PNU 600 ... 608 are used (➔ Section 5.3).

Tab. 3.19 Parameters involved, record mode

3.3.1 Start of a record



t_{min}: at least 1 bus cycle waiting time. Recommendation: 1 control cycle.
Not required with use of consistent data transmission

1. Set the desired record number in the output data of the controller. Until the start, the CMAX continues to reply with the number of the record last processed.
   SCON.FAULT must be 0 during the entire sequence.
2. If SPOS.ACK (acknowledge start) = 0, the controller can initiate execution of the record with a rising edge at CPOS.START.
3. The CMAX accepts the record number and starts the movement command, i.e. the setpoint curve. In the controller input data, the actual record number is set to the current record and SPOS.MC is reset.
4. With the rising edge at SPOS.ACK, the CMAX signals that the controller output data have been accepted and the movement command is active.
5. The controller recognises the acknowledgement SPOS.ACK = 1 in its input data and resets CPOS.START in its output data.
6. CMAX acknowledges the resetting of CPOS.START by resetting SPOS.ACK.
7. After the controller has identified SPOS.ACK = 0, new setpoint values may be written to its output data. The CMAX ignores this until the next start.
   When the record or record chain has been concluded, SPOS.MC is set.

Fig. 3.13 Record start process

Notes

– As soon as the controller detects the rising edge at SPOS.ACK, it can assume that MC is valid. From the point of view of the controller, the falling edge at MC can occur at the same time as the rising edge at ACK. 3 and 4 then cannot be distinguished.
– In the event of error messages, the movement command might not be acknowledged with SPOS.ACK (depending on the error). For this reason, the SCON.FAULT bit must always also be evaluated.

Typical causes of error in applications

– Homing has not been carried out.
– Selection of an invalid record number or a record that has not been initialised.
– The setpoint value is outside of the software end positions.
– Error in the record parameters, e.g. invalid step enabling condition (➔ Section 3.3.3).
– Subsequent record with active record sequencing not initialised.
– If the next record is configured with an automatic profile, only the condition MC (or none) are permissible. Otherwise, a warning (W37) is signaled and the free profile is used.
– The CMAX does not react to the rising edge at CPOS.START:
  It must be checked whether SPOS.ACK was really reset. After the controller sets CPOS.START = 0 (Fig. 3.13 6), it must wait for SPOS.ACK = 0 (Fig. 3.13 7). Otherwise, it may be that the time for CPOS.START = 0 is too short to be recognised by the CMAX.

Notes regarding force control

If “Force control” is set as the control mode with a rising edge at CPOS.START in RCB1, the CMAX interprets the target specification as a force value. It activates the force control and adjusts the value with the parameterised ramp ➔ Section 3.1.2.

3.3.2 Record structure

A movement command in record mode is described by a record made up of parameters and setpoint values. Every parameter or setpoint value is addressed by its own PNU. Each record consists of the PNUs with the same subindex (➔ Tab. 3.21).

PNU [1]	Name	Position control	Force control
401	Record control byte 1 RCB1	Setting for movement command: absolute/relative, position/force control, ...	
402	Record control byte 2 RCB2	Record control: Settings for conditional record sequencing	
403	Default values	Controls use of global default values	
404	Setpoint value	Position setpoint value	Force setpoint value
405	Preselected value	Preselected value for record sequencing corresponding to RCB2	
406	Speed	Speed	
407	Acceleration	Acceleration	Not used
408	Deceleration	Deceleration	Not used
410	Payload	Payload	
411	Tolerance	Position tolerance	Force tolerance
412	Force ramp	Not used	Force ramp

1) Depending on PNU 403 (default value record), the global default values are used (➔ Tab. 3.19).

Tab. 3.20 Parameters of a record

Record no.	PNU										
	RCB1	RCB2	Specifi-cation	Set-point value	Presel ection	Speed	Accel-eration	Decel-eration	Pay-load	Toler-ance	Force ramp
1	401:01	402:01	403:01	404:01	405:01	406:01	407:01	408:01	410:01	411:01	412:01
2	401:02	402:02	403:02	404:02	405:02	406:02	407:02	408:02	410:02	411:02	412:02
...	...	...	...	...	...	...	...	...	...	...	...
64	401:64	402:64	403:64	404:64	405:64	406:64	407:64	408:64	410:64	411:64	412:64

Tab. 3.21 Structure of the record table

3.3.3 Conditional record sequencing / record chaining (PNU 402)

The record mode allows chaining several movement commands. This means that, with a rising edge at CPOS.START, several records are automatically executed one after the other. This allows a travel profile to be defined, such as switching to another speed after a position is reached.
To do this, a (decimal) condition is set in RCB2 to define that the following record N + 1 is automatically executed after the current record. A numerical value is usually linked with the condition, e.g. the sequencing position. This value is defined in PNU 405 (preselected value).
Motion Complete (SPOS.MC) is only set after the last executed record. If the MC condition is reached before the switching condition is met, the record chain is interrupted and SPOS.MC is set. In this case, bit 3 in the record status byte (RSB.RCE) is set and an error is signaled.
Record sequencing in record 64 is not permissible and results in an error message when the record starts.
Sequencing can be suppressed by setting bit B7. In this case, the CMAX executes the addressed record without an error message. Sequencing is ignored, however, and the next record is not executed.
This function is not meant for normal operation (debugging function with FCT).

Record control byte 2 (PNU 402)	
Bit 0 ... 6	Numerical value 0...128: Step enabling condition as a list (➔ Tab. 3.24)
Bit 7	= 0: Record sequencing (bit 0...6) is not blocked (specification) = 1: Record sequencing blocked

Tab. 3.22 Settings for conditional record sequencing

Important signals for record sequencing

Signal	Description
CPOS.START	Start of the first record of the record chaining
SPOS.MC	Motion complete: End of the record chain
RSB.RC1	First record executed (First Record Chain executed): After the first sequence, bit 0 in the record status byte (RSB) is set
RSB.RCC	All records executed (Record Chain Complete): All parameterised record sequences have been executed to the end. To check for complete working off of record sequences, an evaluation of RSB.RCC at the end of positioning is recommended (with SPOS.MC=1).
RSB.RCE	Error in record sequencing (Record Chain Error): A record sequencing has been parameterised which could not be executed.

Tab. 3.23 Signals for conditional record sequencing

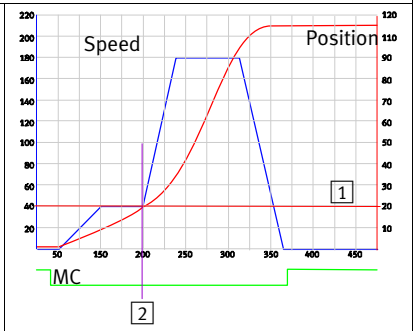
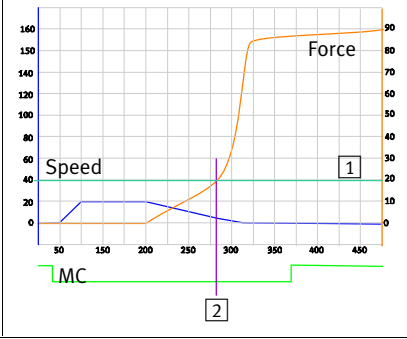
Special case: Switching between force and position

If there is record sequencing with switching from force control to position control, the drive first stops. This is necessary so that the forces which were built up before can be relieved.
Only afterwards is the new target position approached.

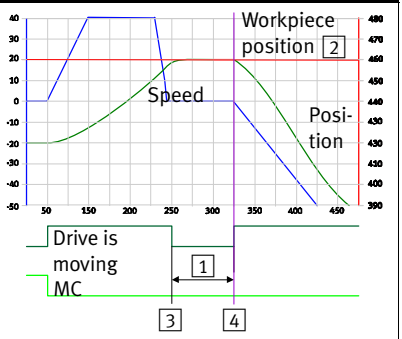
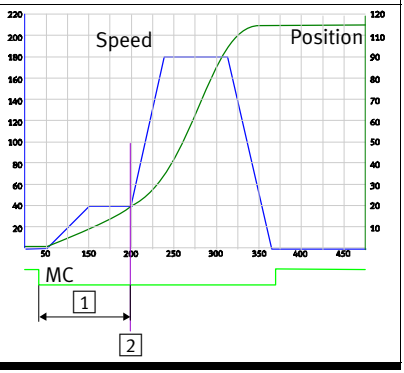
Limitation: Switching to a record with automatic profile

Record sequencing to a record with an automatic profile is only possible with the step enabling condition 12 “MC”.
If record sequencing takes place to a record with automatic profile with a condition other than “MC”, a warning (W37) is signaled during execution and the free profile is used. In that case, the default values (PNU 600/602/603) are used for speed, acceleration and deceleration.

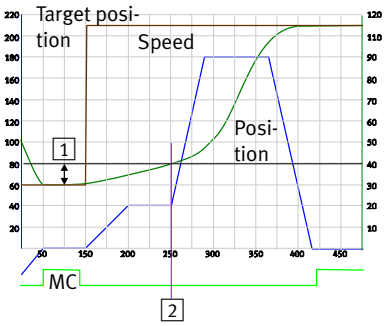
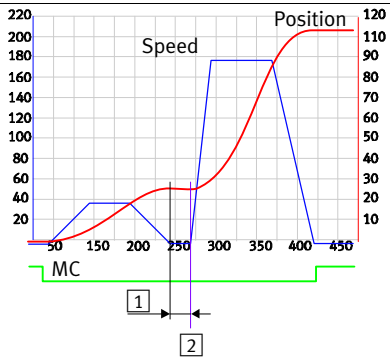
Defined step enabling conditions in the CMAX

Value	Condition	Description	
0	–	No sequencing.	
1	–	Reserved	
2	Position	The preselected value is interpreted as the position value 1. Sequencing happens as soon as the current actual position exceeds the preselected value in the direction of travel 2.	
3	Force	The preselected value is interpreted as the force value 1. There is a switch when the current actual force has exceeded the preselected value 2. The first command doesn't necessarily have to be a force command. Example: Slow positioning to block. When the force threshold has been reached, force control is switched to.	
		Notes: – Exceeding means that the actual force is closer to the target force than the switch value. – In case of switching from a position command: Besides the expected counteracting force, the force for accelerating the mass load and the friction of the system also determine the current force value, and with this, the switching position. Therefore, only a small degree of switching position reproducibility is to be expected in this case. Only when the axis is positioned against a spring force, for example, and the force which occurs here is more than twice the frictional forces, including the acceleration force, does the switch result in more-or-less reproducible behaviour.	

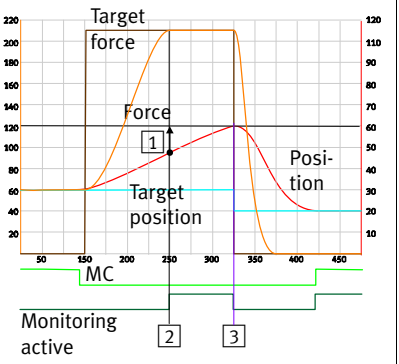
Defined step enabling conditions in the CMAX

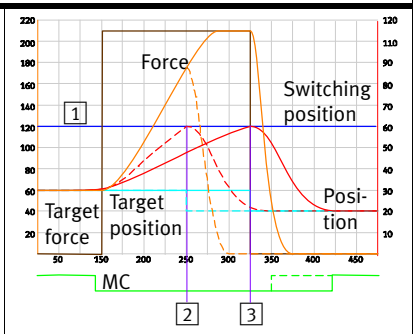
Value	Condition	Description	
4	Standstill	The preselected value is interpreted as the time T1 [1]. Sequencing: The drive moves slowly until it reaches an unknown workpiece position [2] (“on block”) and then comes to a stop [3]. When a standstill is reached, the time T1 begins. As soon as this has elapsed, the next record is executed [4]. If the drive did not move until 100 ms after the start of the record (e.g. because it is already at the end point), standstill is also detected and the time T1 is started.	
		Notes: – To avoid a timeout, the configured timeout time is prolonged by the time T1 in this record. – If a standstill is detected, after the time elapses, switching continues, even if the axis is moving again (no monitoring time). – The axis can not only be stopped with an obstacle (wanted or unwanted), but also with a lack of pressure. – For switching from a force command: Since the force ramp also determines the switching point of the force at a standstill, only low reproducibility with regard to the position and force value can be expected.	
5	Time	The preselected value is interpreted as the time T1 [1]. The time T1 begins from the start of the record. The next record is switched to once the time has elapsed [2]. MC must not have been reached yet.	

Defined step enabling conditions in the CMAX

Value	Condition	Description	
6 ... 10	–	Reserved	
11	Stroke	The preselected value is interpreted as the stroke 1 (position difference, with sign). The stroke refers to the last target position, not the actual position reached during the last positioning. The switch 2 occurs after reaching the specified stroke. If the current record has already been started by means of chaining, the preselected value refers to the switching position. If the record is started without MC, the preselected value refers to the starting position.	
12	MC	The preselected value includes a waiting time T1 1 in milliseconds. The waiting time starts after reaching the target value, i.e. when the MC condition is met. Switching occurs after this waiting time 2 elapses. Therefore, the axis as a rule is at a standstill for a moment during positioning, but not necessarily during force control.	
		Note: – SPOS.MC is also **not** set to 1 for this step enabling condition while the record is being processed, but only when the CMAX has executed the last chained record.	

Defined step enabling conditions in the CMAX

Value	Condition	Description	
13	Stroke after force	Sequencing is only permissible in a force record. The preselected value is interpreted as the stroke 1 (position difference, with sign). After reaching the MC condition for the force command 2, monitoring of the actual position is started. Sequencing 3 occurs as soon as the stroke 1 set in the preselected value has been passed. The stroke specified in the preselected value refers to the actual position at the time the MC condition was reached for the force command 2.	
		Notes: – The position in some cases is difficult to reproduce and the absolute position is normally not known or visible, because the position at the time the MC condition was met is not output. – The direction of the stroke must agree with the specified direction in which the force acts. Otherwise, a diagnostic message (W27/E27) is output. – If the stroke or speed monitoring is violated, the current positioning record is ended and record switching does not occur. – The timeout time (force control, PNU 1163) begins to elapse when the MC condition is met for the force command. If the stroke is not reached within the timeout time, the current positioning record is ended, no record sequencing occurs, SPOS.MC and RSB.RCE are set to 1 and a diagnostic message (W28/E28) is output. – If the timeout time for force control is deactivated (set to 0), the drive waits indefinitely for the switching position to be reached.	

Defined step enabling conditions in the CMAX			
Value	Condition	Description	
14	Position with force	Sequencing is only permissible in a force record. The preselected value is interpreted as the position value 1. Sequencing occurs as soon as the current actual position reaches or exceeds the preselected value, independently of whether the MC condition for the force command has already been met (case 3, continuous signals) or not (case 2, dashed signals).	
		Notes: – The direction of the switching position with respect to the starting position must agree with the specified direction of the acting force. Otherwise, a diagnostic message (W27/E27) is output. – If the stroke or speed monitoring is violated, the current positioning record is ended and record switching does not occur. – The timeout time (force control, PNU 1163) begins to elapse again when the MC condition is met for the force command. If the switching position is not reached within the timeout time, the current positioning record is ended, no record sequencing occurs, SPOS.MC and RSB.RCE are set to 1 and a diagnostic message (W28/E28) is output. – If the timeout time for force control is deactivated (set to 0), the drive might wait indefinitely for the record sequencing.	
15 ... 128	–	Reserved	

Tab. 3.24 Step enabling conditions

3.4 Direct mode

In the “Operation enabled” status, in direct mode, a movement command is formulated directly in the I/O data, which are transmitted by the bus node (e.g. via the fieldbus) and started. The setpoint values are thereby reserved in the higher-order controller.

Typical applications

The function is used in the following situations:

– Selection-free approach to positions within the effective stroke.
– The target positions are unknown during designing or change frequently (e.g. several different workpiece positions).
– A traversing profile consisting of chaining records is not necessary.
– The drive should follow a setpoint value continuously.
– The setpoint positions should be reserved in the higher-order controller for another reason.

Typical causes of error in applications

– No homing carried out
– Target position or target force cannot be reached or is outside the software end positions
– Timeout (target position or target force is not reached) ➔ Section 3.4.2

Regulating functions

Tab. 3.25 shows the supported regulating functions in direct mode.

Regulating function	is supported
Point-to-point (PTP) positioning	Yes
Positioning continuously, tracking mode	Yes
Force controls PTP (point to point)	Yes
Continuous force control	No
On-the-fly setpoint value switching (new movement command before MC)	Yes

Tab. 3.25 Supported controller functions

Limitation of the setpoint values

The main setpoint value is limited to software or hardware end positions or the set force limitation or the calculated maximum achievable force. If the permitted limits are violated, an error is signaled.
The secondary setpoint value is limited to 0 % ... 100 % and to the maximum permissible range of values of the corresponding base parameter (➔ Tab. 3.26). If the permitted limits are violated for the secondary setpoint value, an error is signaled.

Note: If the secondary setpoint value is configured as speed or force ramp, the movement command is executed with a minimum speed or force ramp if 0 is accidentally specified.

Overview of parameters involved (➔ Section C.2)

Parameters involved	**Description**	**PNU[1)]**
Position control	Base speed[2)]	600 / 540
	Direct mode acceleration	602 / 541
	Direct mode deceleration[3)]	603 / 542
	Payload[2)]	605 / 544
	Tolerance	606 / 545
Force control	Base value force ramp[2)]	608 / 550
	Payload[2)]	605 / 551
	Force tolerance	607 / 552
	Speed limit for force control	601 / 554
Start (FHPP)	CPOS.START = rising edge: Start CDIR.REL = absolute/relative setpoint value CDIR.COM1/CDIR.COM2 = control mode (➔ Section 2.2.4) CDIR.CONT = continuous tracking Jogging and referencing have priority	
Acknowledgement (FHPP)	SPOS.MC = 0: Motion complete, movement command active SPOS.ACK = rising edge: Acknowledge start	

1) Depending on the parameterisation, the default values from PNU 600 ... 608 or the base values PNU 540 ... 554 are used (➔ Section 5.3).
2) The higher-order controller transfers in the secondary setpoint value a percentage which is multiplied by the base value in order to get the final setpoint value.
3) With continuous setpoint specification (tracking mode), deceleration is not taken into account, but the specification for the acceleration is also used for the deceleration.

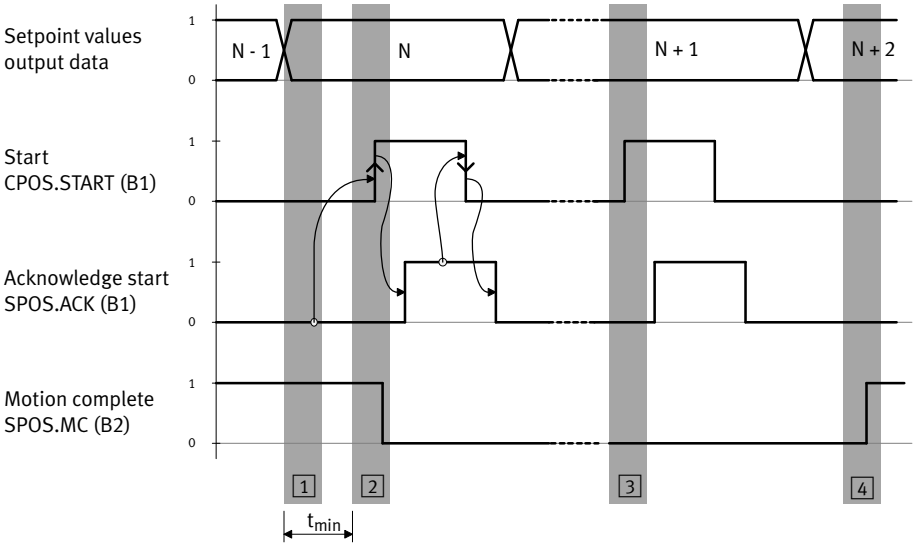
Tab. 3.26 Parameters involved in direct mode

3.4.1 Start of a movement command

Primary setpoint value
In the primary setpoint value, a position or force setpoint value is specified, depending on the selected control mode. The setpoint value may be absolute or relative.

Secondary setpoint value
Speed, force ramp or payload is specified as the secondary setpoint value, depending on the configuration (PNU 523:01, 05). A percentage that affects the corresponding base value is specified in each secondary setpoint value (➔ Tab. 3.26). The secondary setpoint value is only transferred at the start (rising edge at CPOS.START); changes without a new rising edge at POS.START are ignored.
If the secondary setpoint value is configured as speed or force ramp, the payload is set at 100 % of the base value. Care must be taken here that 0 is not accidentally transmitted in the secondary setpoint value, or the axis will travel very slowly.
If the secondary setpoint value is configured as payload, the speed or force ramp is set at 100 % of the base value.

Start of a movement command
Fig. 3.14 shows the I/O signals when a movement command is started.



t_{min}: at least 1 bus cycle waiting time. Recommendation: 1 control cycle.
Not required with use of consistent data transmission.

1 The desired setpoint value (position, force) and the positioning condition (absolute/relative, speed or force ramp, etc.) are set in the output data of the controller.
SCON.FAULT must be 0 during the entire sequence.

2 With the rising edge at CPOS.START, the CMAX transfers the setpoint values currently present, starts the movement command, sets SPOS.MC = 0 and acknowledges the starting edge with SPOS.ACK = 1.

3 After resetting CPOS.START and the acknowledgement SPOS.ACK = 0, a new setpoint value can be started at any time. There is no need to wait for MC.
The CMAX internally calculates the necessary steps to execute the new movement command. If a change of direction is required, for example, the drive is first braked until speed = 0 is reached. Only then is the new setpoint position transferred to the controller. No error message is generated.

4 Once the last setpoint value (position, force) is reached, SPOS.MC = 1 is set.

Fig. 3.14 Start of the movement command

The sequence of the other control and status bits behaves correspondingly to the record mode (➔ Section 3.3.1, Fig. 3.13).

Notes:

– As soon as the controller detects the rising edge at SPOS.ACK, it can assume that MC is valid. From the point of view of the controller, the falling edge at SPOS.MC can occur at the same time with the rising edge at SPOS.ACK.
– In the event of error messages, the movement command might not be acknowledged with SPOS.ACK. For this reason, the SCON.FAULT bit must always also be evaluated.

3.4.2 Continuous setpoint specification (tracking mode)

With the continuous setpoint specification, the controller can transfer new setpoint values to the CMAX at any time. Tracking mode is permitted only for position control; the setpoint values can only be specified as absolute values (CDIR.REL=0).

Primary setpoint value

In the primary setpoint value, beginning with the start, new setpoint positions can be specified as long as CPOS.START = 1 is set, for example, regularly every 10 milliseconds or at irregular intervals, like 10 ms – 30 ms – 2 s – 10 ms – 30 ms – 20 ms – 15 ms – 10 ms, etc. The setpoint values can be absolutely any, both with regard to the stroke length as well as the direction of movement.

Secondary setpoint value

Speed or payload is specified as the secondary setpoint value, depending on the configuration (PNU 523:01). A percentage that affects the corresponding base value is specified in each secondary setpoint value (base value speed, PNU 600/540, or payload, PNU 605/544; ➔ Tab. 3.26). The secondary setpoint value is only transferred at the start (rising edge at CPOS.START); changes without a new rising edge at POS.START are ignored.

If the secondary setpoint value is configured as speed, the payload is set at 100 % of the base value. Care must be taken here that 0 is not accidentally transmitted in the secondary setpoint value, or the axis will travel very slowly.

If the secondary setpoint value is configured as payload, the speed is set at 100 % of the base value.

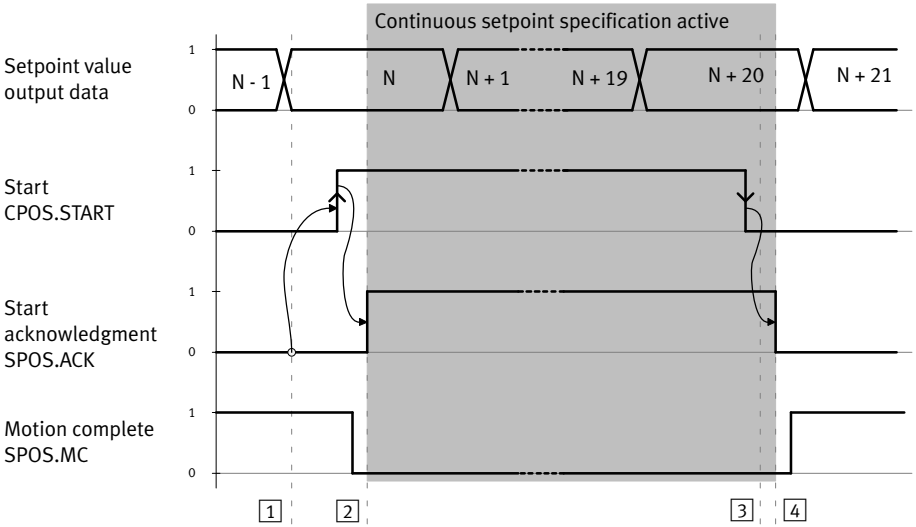
Start of continuous setpoint specification

All setpoint values are transmitted with a rising edge at CPOS.START. The CMAX then internally calculates a path whose speed and acceleration are limited to the maximum values of the speed (secondary setpoint value, or PNU 600 / 540) and acceleration (PNU 602 / 541).

With continuous setpoint value specification, the acceleration values are also used for deceleration; other deceleration values (PNU 603/542) are not considered.

If concrete acceleration and deceleration are to be specified for point-to-point positioning, the normal movement command must therefore be used in direct mode.

Fig. 3.15 shows the I/O signals when a movement command with continuous setpoint specification is started.



1 In the output data of the controller, set the desired setpoint position in the main setpoint value and the speed or payload in the secondary setpoint value.

2 If SPOS.ACK = 0 and SPOS.MC = 1 is 1, the controller can start continuous setpoint value mode with the rising edge at CPOS.START 2. The CMAX transfers the setpoint values currently present, starts the movement command, sets SPOS.MC = 0 and acknowledges the starting edge with SPOS.ACK = 1.

3 As long as CPOS.START = 1, the setpoint value may be changed at any time. The CMAX leads the position of the axis toward the setpoint value; speed and acceleration are limited corresponding to the base values from Tab. 3.26.

4 With a falling edge at CPOS.START 3, the setpoint tracking is ended 4, the drive stopped and setpoint position = actual position is set.

Fig. 3.15 Start of the movement command with continuous setpoint specification

4 Diagnostics and error handling

4.1 Summary of diagnostics options

Access/ function	Diagnostics option	Brief description	Detailed description
Local Display on the device	LED display	The LEDs directly display operating and diagnostic information. Fast on-the-spot diagnostics	CMAX system description
	Display/7-segments display	The operating status and diagnostic information are shown on the display. Fast diagnostics with on-site status and error detection	CMAX system description
	CPX-MMI	CPX module diagnostics[1] can be displayed on the CPX handheld terminal ➔ Section 4.2.3.	Description of the CPX-MMI
Local with PC (e.g. during commissioning)	FCT with CMAX plug-in	Plain-text display of all diagnostic information during startup and servicing. Full access to the diagnostic function of the CMAX.	Help for the CMAX FCT plug-in
	CPX-FMT	The CPX-FMT can be used to display the CPX module diagnostics[1] ➔ Section 4.2.3.	Help for the CPX-FMT
Higher-order controller over I/O data	Module input and output data	In the input data, diagnostic information is permanently transferred (e.g. the bits SCON.WARN and SCON.FAULT or actual values, such as the current position).	Section 2.2
	CPX status bits, I/O diagnostic interface	The CPX module diagnostics[1] are reported to the CPX node ➔ Section 4.2.3. Optimum integration into the CPX module concept.	Section 4.5
Higher-order controller Through communication profile	FHPP diagnostics	Diagnostic parameters, diagnostic memory	Section 4.3

1) Only the groups of the CMAX are displayed in the CPX diagnostics.

Tab. 4.1 Diagnostics options

4.2 Faults and warnings

The CMAX permanently monitors the operating status and issues corresponding diagnostic messages in the event of deviations from the setpoint status.
Diagnostic messages for malfunctions are categorised as faults or warnings, depending on the cause and effect, and can be evaluated in detail and processed.

Malfunctions	Effect	Acknowledge
Faults Events and statuses that jeopardize or prevent correct operation of the CMAX.	– Red error LED is illuminated – Error number E... is shown on the display – SCON.FAULT = 1 is set – Effect on the sequence control dependent on the malfunction step ➔ Section 4.2.1	Required ➔ Section 4.2.2
Warnings Events and statuses that may impair operation.	– SCON.WARN = 1 is set – The sequence control and the axis are not affected	Not required

Tab. 4.2 Faults and warnings

List of faults and warnings ➔ Section 4.2.4.
With FCT or PNU 228:03, some diagnostic messages can be classified optionally as warning or fault. Section 4.2.4 shows the step assigned at the plant (e.g. F2). Alternative steps that can be set are listed in brackets. F2 (W) therefore means “factory setting step F2, alternative step W”.

4.2.1 Effect on the sequence control and axis – malfunction step

Dependent on the malfunction step, faults and warnings have the following effect:

Malfunction step	Effects on		SCON[1)]				SPOS[1)]	
	Sequence control	Axis	FAULT	WARN	READY	ENABLED	MC	REF
W (Warning)	– (None)		–	1	–	–	–	–
F1 (Fault 1)	Transition to the “fault” status	Stop	1	–	0	–	1	–
F2 (Fault 2)		Drive blocked	1	–	0	0	1	–
FS (System fault)	System fully stopped		x	x	x	x	x	x

1) Status of status bits: – = no effect; 0 = logic 0, 1 = logic 1; x = no updating

Tab. 4.3 Malfunction steps

– F1 (fault 1): The axis is stopped. Stop behaviour ➔ Section 3.1.4.
– F2 (fault 2): The drive is blocked (controller inactive); the drive moves using residual energy until it comes to rest. If communication with the displacement encoder/sensor interface fails, the possibility exists that homing may be lost (SPOS.REF = 0).
– FS (system fault): It may no longer be possible to update the I/O data.
Switching off/on required.

4.2.2 Acknowledgement of faults and warnings – reset type

Acknowledge fault

Faults must be acknowledged with CCON.RESET before a new positioning command can be started. In most cases, the cause of the fault must be eliminated.

1. Rising edge at CCON.RESET.
2. Wait 3 s (depending on the fault, the CMAX requires a maximum of 3 seconds, e.g. to initialize the axis).
3. Check whether the fault has been eliminated:
   – If SCON.FAULT = 0: ok
   – If SCON.FAULT = 1: Check error number, eliminate cause ➔ Section 4.2.4.

In principle, the CMAX always tries to acknowledge all currently pending faults. If several faults are active at the same time, the behaviour is oriented on the most serious fault ➔ Section 4.2.1.

If there are several faults pending and one fault can be deleted after a reset, but not others, one of the remaining faults is displayed after the reset.

The reactions of the CMAX to acknowledgement of various faults are divided into reset types ➔ Tab. 4.4.

Reset type	Significance	Action when acknowledging
R	**R**eset	The “fault” status is exited
F	Reset if **f**ixed	The “fault” status is exited if the cause has already been eliminated (example: E51 active and load voltage has not been applied again).
N	**N**ew initialisation and reset	The CMAX newly initializes the components valve and sensor interface as well as the controller. If no fault occurs, the “fault” status is exited. The maximum time for a restart is 3 s. After the restart, homing must be performed again.
Poff	Reset with **p**ower **off**	The CMAX does not react to acknowledgement (CCON.RESET). The CPX terminal with the CMAX must be switched off and back on again or a “Restart CPX terminal” must be performed in the FCT (from V2.2).

Tab. 4.4 Reset types

Acknowledging warnings

Warnings do not have to be acknowledged. With rising edge at CPOS.START (new positioning command) or CCON.RESET (provided the cause has been eliminated), SCON.WARN = 0 is set.

4.2.3 Illustration of CMAX error numbers in the CPX terminal

The CMAX faults and warnings are arranged in groups. The first digit of the fault and warning number specifies the group. The second digit points out the specific message. The CMAX reports to the CPX node only the group of the message. The groups of the CMAX are the assigned to the group of numbers 100 to 108 of the CPX terminal (➔ CPX system description, error numbers). The last digit of the diagnostic message specifies the group.

Specification of the group in the diagnostic message of the CPX terminal is not sufficient for detailed evaluation. Evaluate error and warning numbers via the I/O data (PNU 220, 224, ...), FCT plug-in or the display.

Allocation of CPX error numbers and groups of the CMAX

CPX fault	CPX fault text (MMI, configuration software)	Group ➔ Section 4.2.4	
100	[Configuration error]	0	Configuration error
101	[Execution error]	1	Execution error
102	[Record error]	2	Positioning record error
103	[Control error]	3	Control error
104	[System error A]	4	System error A
105	[System error B]	5	System error B
106	[Error in valve]	6	Error in valve
107	[Controller error]	7	Controller error
108	[Encoder error]	8	Displacement encoder error

Tab. 4.5 CPX error numbers and groups of the CMAX

4.2.4 Error and warning numbers

Information on the malfunction level and the reset type ➔ Sections 4.2.1 and 4.2.2.
FCT supplies additional information on many diagnostic events (➔ FCT). Internally, the additional information is stored in the PNU 203 (➔ Section 4.3.3).

Group 0 – Configuration errors
CPX error group 100 (CPX-MMI: [Configuration error])

No.	Message		Malfunction level	Reset type
01	**The nominal configuration deviates from the actual configuration** The nominal configuration deviates from actual configuration		F2	N
	Note	The movement test is reset to avoid tubing connection errors. The CMAX has C03 status. The movement test should then be run once more.		
	Cause	A component on the axis string does not correspond to the nominal configuration: – displacement encoder or sensor interface (type, length) – cylinder (type, length, diameter) – valve type		
	Measure	• Check component. Replace defective or incorrect components. • Adopt actual configuration (download).		
	Cause	The displacement encoder and valve have been exchanged and no longer match the target configuration, or the serial numbers have changed.		
	Measure	• Check the axis configuration. Check to make sure 2 axis strings have not been interchanged.		
02	**Unknown valve** Unknown valve		F2	N
	Cause	Connected valve is not supported.		
	Measure	• Exchange valve or • update firmware.		
03	**Unknown cylinder** Unknown cylinder		F2	N
	Cause	Connected cylinder or sensor interface is not supported.		
	Measure	• Replace cylinder or sensor interface. • Update firmware.		
04	**Unknown displacement encoder or unknown sensor interface** Unknown displacement encoder or unknown sensor interface		F2	N
	Cause	Connected displacement encoder or sensor interface is not supported.		
	Measure	• Replace displacement encoder or sensor interface. • Update firmware.		

Group 0 – Configuration errors
CPX error group 100 (CPX-MMI: [Configuration error])

No.	Message		Malfunction level	Reset type
05	**Project not loaded completely or block download active** Project not loaded completely or block download active		F2	R
	Cause	Drive cannot be enabled because the target configuration is not yet complete (configuration status C00, C01 or C02).		
	Measure	• Complete the nominal configuration, e.g. download project again.		
	Cause	Drive cannot be enabled because the block download is still active.		
	Measure	• End block download. Check and correct the control program (parameterisation).		
08	**Cylinder, valve or sensor interface was replaced** Cylinder, valve or sensor interface was replaced		W	F
	Note	The movement test is reset to avoid tubing connection errors. The CMAX has C03 status. The movement test should then be run once more.		
	Cause	The serial number of a component on the axis string has changed: – drive (displacement encoder) – valve		
	Measure	1. Accept the serial number of the component. 2. Run movement test (recommendation). 3. Carry out identification (recommendation).		
09	**Faulty parameter in the project** Project contains incorrect parameters		F2	N
	Cause	Drive configuration is not supported by the firmware used.		
	Measure	• Update firmware.		
	Cause	Invalid values concerning axis parameters or hardware configuration (e.g. software end positions).		
	Measure	• Determine, check and correct the affected parameters with additional information (diagnostics: Active messages or diagnostic memory)		

Group 1 – Execution error
CPX error group 101 (CPX-MMI: [Execution error])

No.	Message		Malfunction level	Reset type
10	**Homing not executed** Homing not executed		F1	R
	Cause	Drive with incremental displacement encoder is not referenced.		
	Measure	• Carry out homing.		
11	**Homing not required** Homing not required		F1	R
	Cause	Homing with absolute displacement encoder.		
	Measure	• Do not carry out homing.		

Group 1 – Execution error
CPX error group 101 (CPX-MMI: [Execution error])

No.	Message		Malfunction level	Reset type
13	**Wrong direction of movement during movement test** Wrong direction of movement during movement test		F2	R
	Cause Measure	Cylinder and valve are incorrectly connected. • Check and correct the tubing connection.		
14	**Movement test not carried out** Movement test not carried out		F2	R
	Cause Measure	Positioning command without valid movement test. • Run movement test (recommended) or skip.		
15	**Result of the movement test not clear** Result of the movement test not clear		F1	R
	Cause Measure	Drive jammed. • Check friction of the drive and guide. • Check pressure build-up with trace.		
	Cause Measure	Obstacle in the travel path • Check travel path and software end positions.		
	Cause Measure	Working pressure insufficient to move the load. • Set sufficient working pressure and check the load.		
	Cause Measure	Cylinder not correctly designed. • Check size and correct.		
	Cause Measure	Valve defective. • Check pressure build-up with trace. Replace valve if defective.		
	Cause Measure	Faulty tubing connection. • Check tubing connection.		
	Cause Measure	Valves (additional pneumatic circuit) installed between the valve and cylinder are closed. • Open valves.		
16	**Identification failed** Identification failed		F1	R
	Cause Measure	Incorrect base load and/or payload parameterised or incorrect payload transferred to parameter 2 (byte 5 ... 8 in commissioning mode). • Check load and data.		
	Cause Measure	Too much mechanical play in the system. • Check system structure.		
	Cause Measure	Constructional design not stable enough. • Check system structure.		
	Cause Measure	Tubes used are too long. • Move valve closer to the drive.		
	Cause Measure	Compressed air not sufficiently stable. • Check compressed air supply.		

Group 1 – Execution error
CPX error group 101 (CPX-MMI: [Execution error])

No.	Message		Malfunction level	Reset type
17	**Identification was not yet executed** Identification not yet executed		W	F
	Cause	Identification was not executed before record start and direct mode.		
	Measure	• Carry out identification.		
18	**Clamping unit was activated despite operation enable** Clamping unit was activated with operation enable		W	F
	Cause	Operation enable was granted (CCON.STOP = 1), although the clamping unit was not yet released, or the clamping unit was closed without the operation enable having been blocked beforehand (CCON.STOP=0).		
	Measure	• Remove operation enable. • Release clamping unit. • Correct the sequence when changing from operation enable and clamping unit.		
19	**Impermissible change of operating mode** Impermissible change of operation mode		F1	R
	Cause	Change between record select mode and direct mode with active positioning command (SPOS.MC=0).		
	Measure	• Only perform the shift after positioning command is completed (SPOS.MC = 1).		
	Cause	Change between record select mode or direct mode and commissioning or parameterisation during active operation enable (CCON.STOP = 1).		
	Measure	• Only perform the shift without operation enable. Set CCON.STOP = 0 and wait for SCON.READY = 0 and SPOS.MC = 1.		

Group 2 – Position set errors
CPX error group 102 (CPX-MMI: [Record error])

No.	Message		Malfunction level	Reset type
21	**Invalid record number** Invalid record number		F1	R
	Cause	At start, an invalid record number was pending (0 or › 64).		
	Measure	• Check record numbers and correct (first transfer record number, then starting edge).		
22	**Record is not configured** Record is not configured		F1	R
	Cause	Retrieved record was not configured and contains no valid positioning data.		
	Measure	• Check record and parameterise.		

Group 2 – Position set errors
CPX error group 102 (CPX-MMI: [Record error])

No.	Message		Malfunction level	Reset type
23	**Record is blocked** Record is locked		F1	R
	Cause Measure	The retrieved record is not approved for execution (➔ PNU 403). • Check and enable positioning record.		
24	**Step enabling condition is not permissible** Step enabling condition is not permissible		F1	R
	Cause Measure	The demanded step enabling condition is invalid. • Check and correct the step enabling condition.		
	Cause Measure	Step enabling parameterised in record 64. • Remove step enabling condition in record 64.		
	Cause Measure	The selected step enabling condition is not permissible when using a DSMI. DSMI does not support force control. • Correct step enabling condition.		
	Cause Measure	The selected step enabling condition is only permissible in a record with force control. • Check and correct record.		
27	**Step enabling condition cannot be reached during positioning task** Step enabling condition cannot be reached during positioning task		F1 (W)	R
	Note	Message can be parameterised alternatively as a warning (W) or error (F1).		
	Cause Measure	Step enabling position does not lie between the start position (last setpoint or actual value at the time of the switch) and the new setpoint position, or both positions are the same. • Check and correct the step enabling condition. Check the program sequence in the controller. After a stop or error, the previous position must be approached again.		
	Cause Measure	The switching force is not between the starting force (last setpoint or actual value at the time of switching) and the new force setpoint or both forces are the same. • Check and correct the step enabling condition. Check the program sequence in the controller. After a stop or error, the previous position must be approached again or the previous force command repeated.		
28	**Step enabling condition was not reached** Step enabling condition was not reached		F1 (W)	R
	Note	Message can be parameterised alternatively as a warning (W) or error (F1).		
	Cause Measure	Step enabling was not executed. MC was reached before the step enabling condition was fulfilled. • Check step enabling condition. • Check the program sequence in the controller.		

Group 3 – Control error
CPX error group 103 (CPX-MMI: [Control error])

No.	Message		Malfunction level	Reset type
30	**Time-out: Target value not reached** Timeout: Target value not reached		F1	R
	Note	The drive did not reach the target tolerance on time (MC monitoring). Record chaining is cancelled. Can, for instance, occur during positioning or jogging on a stop within the effective stroke.		
	Cause Measure	Obstacle in the travel range (only position controller). • Remove obstacle or correct target position.		
	Cause Measure	Compressed air not sufficient. • Check supply pressure, check tubing connection, configure message 50 as an error; enable drive with closed clamping unit only when there is sufficient supply pressure.		
	Cause Measure	Very strong friction or irregular friction (only position controller). • Increase control amplification.		
	Cause Measure	Mechanical play (only position controller) • Check installation: load, stability, guides, check play, repeat identification.		
	Cause Measure	System not optimally configured. • Check configuration (valve, payload, base load, mounting position, supply pressure), increase time-out, increase tolerance.		
	Cause Measure	Modified system behaviour (only position controller). • Repeat identification.		
31	**No movement after start** No movement after start		F1	R
	Note	Time-out: The drive has moved less than 11 mm within the time-out period.		
	Cause Measure	Pressure could not be built up. • Check supply pressure.		
	Cause Measure	Drive jammed or sluggish. • Check guide and mechanical structure.		
	Cause Measure	Working pressure insufficient to move the entire load. • Set sufficient working pressure and check configuration of the load.		
	Cause Measure	Valve defective. • Check pressure build-up with trace; replace valve if defective.		
	Cause Measure	Faulty tubing connection. • Check tubing connection.		
	Cause Measure	Valves (additional pneumatic circuit) installed between the valve and cylinder are closed. • Open valves.		

Group 3 – Control error
CPX error group 103 (CPX-MMI: [Control error])

No.	Message		Malfunction level	Reset type
32	**Target force outside the force limits** Target force outside the force limits		F1 (W)	R
	Note	Message can be parameterised alternatively as a warning (W) or error (F1).		
	Cause Measure	Target force outside the set force limits. • Correct target force or force limit.		
	Cause Measure	The target force is larger than the maximum force that can be reached (the maximum attainable target force determined by the CMAX may deviate from the theoretical value calculated by the FCT). • Correct target force, increase supply pressure, reduce moving load in vertical structure, use larger drive.		
33	**Target position outside the software or hardware end positions** Target position outside the software or hardware end positions		F1 (W)	R
	Note	Message can be parameterised alternatively as an error (F1) or warning (W).		
	Cause Measure	Target position is outside the set software end positions. • Check and correct target position, software end positions and project zero point.		
	Cause Measure	Target position is outside the reachable hardware end positions. • Check and correct target position and project zero point.		
34	**Setpoint value in tracking mode outside the limit values** Setpoint value in tracking mode outside the limit values		W (F1)	F (R)
	Note	Message can be parameterised alternatively as a warning (W) or error (F1).		
	Cause Measure	Setpoint position is outside the set software end positions. • Check and correct setpoint position, software end positions and project zero point.		
	Cause Measure	Setpoint position is outside the reachable hardware end positions. • Check and correct setpoint position and project zero point.		
35	**Software end position passed** Software end position passed		W (F1)	F (R)
	Note	The actual position has exceeded a software end position with active position control, whereby a tolerance of 2 mm has been taken into account. Message can be parameterised alternatively as a warning (W) or error (F1).		
	Cause Measure	The drive was pushed out of the valid range by an external force. • Prevent external force, if possible.		
	Cause Measure	Controllers which are not optimally set can lead to considerable overshooting. • Optimize control, check parametrisation, perform identification again.		

Group 3 – Control error
CPX error group 103 (CPX-MMI: [Control error])

No.	Message		Malfunction level	Reset type
36	**Software end position reached during force control** Software end position reached during force control		F1	R
	Note	The actual position has exceeded a software end position with active force control. A tolerance of 2 mm has been taken into account here.		
	Cause Measure	No workpiece. • Check workpiece, check workpiece position. • Use record sequencing for return travel or stop.		
	Cause Measure	Software end positions can be reached in the desired sequence. • Correct software end positions.		
37	**Switch to Unassigned Profile** Switch to Free Profile		W	R
	Cause	It was attempted to switch from an active positioning command to a positioning command with Auto Profile. In record select mode: Record sequencing with switching condition not identical to “after MC” (12) or start of a new record before CPOS.MC=1 In direct mode: Start of a new positioning command before CPOS.MC=1 The positioning command was not executed as configured in the Auto Profile, but in the Unassigned Profile. For speed, acceleration and deceleration the default values (PNU 600, 602, 603) are used.		
	Measure	• Change subsequent command to Unassigned Profile, parameterise accelerations and speed.		
	Cause	A positioning command is started with Auto Profile, although no dynamic identification was performed yet. The positioning command was not executed as configured in the Auto Profile, but in the Unassigned Profile. For speed, acceleration and deceleration the default values (PNU 600, 602, 603) are used.		
	Measure	• Perform dynamic identification or use Unassigned Profile.		
38	**Critical stroke XLIM reached with force control** Critical stroke XLIM reached with force control		F1	R
	Cause Measure	Parameterised stroke limit is exceeded with force control. • Check workpiece; check critical stroke parameters or deactivate stroke monitoring.		

Group 3 – Control error
CPX error group 103 (CPX-MMI: [Control error])

No.	Message		Malfunction level	Reset type
39	**Critical speed VLIM reached with force control** Critical velocity VLIM reached with force control		F1	R
	Cause Measure	Critical speed has been exceeded with force control. • Check workpiece, check critical speed parameters or deactivate speed monitoring.		
	Cause Measure	The reduced speed parameter of the force record is too large compared to the parameter for critical speed. • The parameters for reduced speed and critical speed are co-ordinated.		
	Cause Measure	In the event of record sequencing to force control, the actual speed of the drive is too high at the time of switching. • Reduce the speed of the previous record, correct the critical speed, deactivate speed monitoring.		

Group 4 – System error A
CPX error group 104 (CPX-MMI: [System error A])

No.	Message		Malfunction level	Reset type
40	**Impermissible control mode with force control** Impermissible control mode with force control		F1	R
	Cause Measure	Force control set for DSMI. • DSMI cannot execute force control commands.		
	Cause Measure	Impermissible control mode set in the RCB1 or CDIR • Correct RCB1 or CDIR.		
	Cause Measure	Continuous setpoint adjustment with force control not possible. • CDIR.CONT must be set to 0.		
41	**Positioning mode relative not permissible in tracking mode** Positioning mode Relative not permissible in tracking mode		F1	R
	Cause Measure	Relative bit (CDIR.REL=1) set in tracking mode. • Continuous setpoint specification may only occur absolutely.		
42	**Reserved control bits set** Reserved control bits set		W	F
	Cause Measure	Reserved bit set in CCON, CPOS or CDIR. • Check and correct CCON, CPOS and CDIR.		

Group 4 – System error A
CPX error group 104 (CPX-MMI: [System error A])

No.	Message		Malfunction level	Reset type
43	**Valve and displacement encoder not connected or communication is faulty** Valve and displacement encoder not connected or communication faulty		F2	N
	Cause	Neither a valve nor a displacement encoder were found during initialization.		
	Measure	• Check installation.		
	Cause	Communication to the valve and displacement encoder is faulty.		
	Measure	• Check cables and components.		
	Cause	Communication faulty, e.g. due to impermissible or damaged components on the axis string.		
	Measure	• Check installation, replace components.		

Group 4 – System error A
CPX error group 104 (CPX-MMI: [System error A])

No.	Message		Malfunction level	Reset type
44	**Teaching not possible** Teaching not possible		F1	R
	Note	Exact cause ➔ Diagnostic memory or additional information in PNU 203.		
	Cause Measure	Teaching (falling edge on CPOS.TEACH) is triggered unintentionally through disconnection or switching off the control. • Only activate CPOS.TEACH = 1 (prepare teaching) directly before the teaching process. Always end teaching immediately.		
	Cause Measure	Teaching not possible in direct mode. • Change operating mode.		
	Cause Measure	Teaching not possible during active commissioning operation. • First end commissioning operation.		
	Cause Measure	In the commissioning mode, the teaching target in parameter 1 is invalid. • Correct parameter 1.		
	Cause Measure	Without reference, teaching is not possible. • Perform homing prior to teaching.		
	Cause Measure	Lower software end position (SWEP) is larger/the same as the upper SWEP when teaching the SWEP in the commissioning mode. The SWEP is not adopted. • Teach upper SWEL first. • Correct the teach position.		
	Cause Measure	Upper software end position (SWEP) is smaller/the same as the lower SWEP when teaching the SWEP in the commissioning mode. The SWEP is not adopted. • Teach lower SWEP first. • Correct the teach position.		
	Cause Measure	Specified record number impermissible when teaching in record select mode. • Correct record number.		
	Cause Measure	Parameterised control mode of the selected record when teaching in record select mode is not permissible. • Correct control mode, correct record number.		
	Cause Measure	Change of operating mode during active teaching process (CPOS.TEACH=1). • Do not change the operating mode during CPOS.TEACH=1.		

Group 4 – System error A
CPX error group 104 (CPX-MMI: [System error A])

No.	Message		Malfunction level	Reset type
45	**Faulty commissioning operation or parameter** Faulty commissioning function or parameter		F1	R
	Cause	Invalid function number when starting a commissioning operation in the commissioning mode (➔ I/O data, commissioning mode - byte 3).		
	Measure	• Correct the function number.		
	Cause	At least one parameter of the started commissioning operation had an invalid value (➔ I/O data, commissioning mode - byte 4 ... 8).		
	Measure	• Check and correct parameter 1 and parameter 2.		
	Cause	Movement test was started when a movement test has already been successfully performed.		
	Measure	• First reset movement test.		
46	**Start during active teach command not permitted** Start during active teach command not permitted		F1	R
	Cause	Commissioning mode: Starting a commissioning operation during an active teaching process (SPOS.TEACH=1) is not permissible		
	Measure	• Do not perform Start during teaching, first end teaching.		
47	**Start during active positioning command not permitted** Start during active positioning command not permitted		F1	R
	Cause	Starting the tracking mode during an active positioning command is not permissible.		
	Measure	• End the active positioning command and wait for Motion Compete (SPOS.MC=1).		
	Cause	Rising edge at CPOS.START not permitted during: – homing run – jogging – commissioning operation		
	Measure	• Active positioning command must be completed or stopped (SPOS.MC=1).		
	Cause	Rising edge at CPOS.HOME not permitted during: – homing run – jogging – commissioning operation – Positioning command		
	Measure	• Active positioning command must be completed or stopped (SPOS.MC=1).		
	Cause	Rising edge at CPOS.JOGN or CPOS.JOGP during active positioning command.		
	Measure	• Active positioning command must be completed or stopped (SPOS.MC=1).		

Group 5 – System error B
CPX error group 105 (CPX-MMI: [System error B])

No.	Message		Malfunction level	Reset type
50	**Supply pressure is too low** Supply pressure is too low		W (F2)	F
	Note	Message can be parameterised alternatively as a warning (W) or error (F2).		
	Cause	Pressure in both cylinder chambers is too low or rises too slowly. The response delay for pressure monitoring can be optimised with FCT or PNU 1144.		
	Measure	• Check compressed air supply. • Adjust response delay parameter (➔ FCT or PNU 1144).		
51	**Load voltage of the controller outside the tolerance range** Controller load voltage outside tolerance range		F2	F
	Cause	Load voltage < 20 V with enabled drive or overload on axis string.		
	Measure	• Check load supply for valves (U_{VAL}).		
52	**Operating voltage of the controller outside the tolerance range** Controller operating voltage outside tolerance range		F2	F
	Cause	Operating voltage < 18 V or overload on the axis string.		
	Measure	• Check operating voltage supply for electronics/sensors ($U_{EL/SEN}$).		
53	**Load voltage overload on the controller** Load voltage overload on the controlle		F2	F
	Cause	Short circuit in the cables of the axis string (between controller and valve or valve and sensor interface).		
	Measure	• Check cables and modules on the axis string (e.g. wire break); replace defective cables.		
	Cause	Overload on valve outputs.		
	Measure	• Check and correct the circuitry for the outputs.		
	Cause	Defect in the valve.		
	Measure	• Check cables and valve systematically; replace defective components.		
	Cause	Defect in CMAX.		
	Measure	• Check CMAX and exchange if defective.		

Group 5 – System error B
CPX error group 105 (CPX-MMI: [System error B])

No.	Message		Malfunction level	Reset type
54	**Operating voltage overload on the controller** Operating voltage overload on the controller		F2	F
	Cause Measure	Short circuit in the cables of the axis string (between controller and valve or valve and sensor interface). • Check cables and modules on the axis string (e.g. wire break); replace defective cables.		
	Cause Measure	Defect in the CMAX controller • Check CMAX; replace if defective.		
	Cause Measure	Defect in the valve • Check cables and valve systematically; replace defective components.		
	Cause Measure	Defect in displacement encoder or sensor interface • Check cables and displacement encoder or sensor interface systematically. Replace defective components.		
56	**Supply pressure too low for homing** Supply pressure too low for homing		F1	R
	Cause Measure	Insufficient working pressure was detected during homing. • Check and correct operating pressure. • Check parameterisation of the operating pressure.		
57	**Time-out diagnostic interface: FCT device control was deactivated** Timeout diagnostic interface: FCT device control was deactivated		W	R
	Cause Measure	Connection between PC and CPX node interrupted. • Check lines.		
	Cause Measure	Communication breakdown due to FCT • Restore connection.		

Group 5 – System error B
CPX error group 105 (CPX-MMI: [System error B])

No.	Message		Malfunction level	Reset type
58	**Handshake error** Handshake error		F1 (W)	R
	Note	Message can be parameterised alternatively as a warning (W) or error (F1).		
	Cause	CPOS.START set with operation enable. Note: If E58 is configured as warning W58, SPOS.ACK = 1 is set with operation enable.		
	Measure	• Reset CPOS.START before operation enable (CPOS.START = 0).		
	Cause	CPOS.HOME set with operation enable. Note: If E58 is configured as warning W58, SPOS.ACK = 1 is set with operation enable.		
	Measure	• Reset CPOS.HOME before operation enable (CPOS.HOME = 0).		
	Cause	Rising edge at CPOS.START or CPOS.HOME or CPOS.JOGP or CPOS.JOGN although SPOS.ACK = 1 (positioning command is ignored).		
	Measure	• New positioning command only with SPOS.ACK = 0		
	Cause	CPOS.JOGP set with operation enable.		
	Measure	• Reset CPOS.JOGP before operation enable (CPOS.JOGP = 0).		
	Cause	CPOS.JOGN set with operation enable.		
	Measure	• Reset CPOS.JOGN before operation enable (CPOS.JOGN = 0).		
	Cause	Simultaneous start of multiple positioning commands.		
	Measure	• Only start one positioning command.		

Group 6 – Valve error
CPX error group 106 (CPX-MMI: [Error in valve])

No.	Message		Malfunction level	Reset type
60	**Valve not connected or communication is faulty** Valve not connected or communication faulty		F2	N
	Cause	When switching on, only the displacement encoder/sensor interface was found. The valve was not detected.		
	Measure	• Check cables to the valve. • Replace valve.		
	Cause	Communication between CMAX and valve was interrupted.		
	Measure	• Check cables of the axis string, valve and displacement encoder systematically; replace defective components.		

Group 6 – Valve error
CPX error group 106 (CPX-MMI: [Error in valve])

No.	Message		Malfunction level	Reset type
61	**Valve hardware faulty** Valve hardware faulty		F2	N
	Cause Measure	The valve reports a hardware error. • Replace valve.		
	Cause Measure	Fault in initialization of the valve. • Replace valve. • Check compatibility of valve and firmware version of the CMAX.		
62	**Valve over-temperature** Valve over-temperature		F2	F
	Cause Measure	The valve reports over-temperature (ambient temperature too high). • Provide sufficient cooling.		
63	**Valve jammed** Valve jammed		F2	F
	Cause Measure	The valve piston does not move as expected. • Replace valve. • Also check the air quality (5 µ-filter and dry air).		
64	**Load voltage of the valve outside the tolerance range** Valve load voltage outside tolerance range		F2	F
	Cause Measure	The valve reports insufficient load voltage. Either the cable between the CMAX and the valve is faulty or the valve. • Check lines on the axis string. • Check valve; replace if defective.		
65	**Operating voltage of the valve outside the tolerance range** Valve operating voltage outside tolerance range		F2	F
	Cause Measure	The valve reports insufficient operating voltage. Either the cable between the CMAX and the valve is faulty or the valve. • Check lines on the axis string. • Check valve; replace if defective.		
66	**Overload at digital output of valve** Overload at digital output of valve		F2	F
	Cause Measure	The valve reports an overload on the digital output. • Check and correct the circuitry.		
67	**Overload at 24 V supply output of valve** Overload at 24 V supply output of valve		F2	F
	Cause Measure	The valve reports an overload on the voltage output. • Check and correct the circuitry.		

Group 6 – Valve error
CPX error group 106 (CPX-MMI: [Error in valve])

No.	Message		Malfunction level	Reset type
68	**Preliminary warning valve over-temperature** Preliminary warning valve over-temperature		W	F
	Cause Measure	The valve reports a high operating temperature. (Ambient temperature too high). • Provide sufficient cooling.		

Group 7 – Controller error
CPX error group 107 (CPX-MMI: [Controller error])

No.	Message		Malfunction level	Reset type
72	**System software error** System software error		FS	Poff
	Cause Measure	Internal software error (firmware). • If possible, read diagnostic memory and save and archive the project. • Switch controller off/on and check whether error occurs again. • Contact Support.		
73	**Controller hardware faulty** Controller hardware faulty		FS	Poff
	Cause Measure	No communication possible with CMAX. Error is only shown on the display. • Exchange CMAX.		
74	**No firmware** No firmware		FS	Poff
	Cause Measure	No firmware. No communication possible via fieldbus. • Firmware download with FCT.		
75	**User data damaged** User data damaged		F2	N
	Cause Measure	Inconsistent user data. • Perform data reset and re-commission the axis.		
76	**Watchdog error; possible data loss; data reset required** Watchdog error: possible data loss, data reset required		F2	F
	Cause Measure	Internal watchdog error • Check whether the CMAX is subjected to strong electromagnetic interference, and eliminate this if applicable. Perform data reset and re-commission the axis. • Contact Support.		

Group 8 – Displacement encoder error
CPX error group 108 (CPX-MMI: [Encoder error])

No.	Message		Malfunction level	Reset type
80	**Displacement encoder not connected or communication is faulty** Displacement encoder not connected or communication faulty		F2	N
	Cause Measure	Displacement encoder/sensor interface was not detected at switch-on. • Replace position measuring system/sensor interface; check the cables.		
	Cause Measure	Communication between CMAX and displacement encoder/sensor interface is faulty. • Check cables of the axis string, valve and displacement encoder/sensor interface systematically; replace if defective.		
81	**Hardware of the displacement encoder or sensor interface defective** Hardware of the displacement encoder or sensor interface faulty		F2	N
	Cause Measure	Hardware of the displacement encoder or sensor interface defective. • Replace displacement encoder/sensor interface.		
	Cause Measure	Error during initialization of the displacement encoder/sensor interface. • Replace displacement encoder/sensor interface. • Check compatibility of the displacement encoder/sensor interface with the firmware version of the CMAX.		
82	**Invalid measured values or displacement encoder error** Invalid measured values or displacement encoder faulty		F2	F
	Cause Measure	DGCI/DDLI: No magnet present. • Check magnet on the displacement encoder, replace magnet holder if defective.		
	Cause Measure	DGCI/DDLI: Several magnets present. • Make sure that no external magnets are in close proximity to the displacement encoder.		
	Cause Measure	DGCI/DDLI: Multiple pulses (e.g. due to vibrations). • Check structure. • Avoid vibration.		
	Cause Measure	DNCI: Sensor error. • Replace sensor head in the DNCI.		
	Cause Measure	Potentiometer: Operating voltage drop below 12 V. • Check operating voltage, check cables for short circuit and corrosion.		
84	**Reference position of the displacement encoder lost** Reference position of the displacement encoder lost		F2	N
	Cause Measure	Although the drive has set the status “Referenced”, the displacement encoder/sensor interface reports the status “Not referenced”. • Reference again.		

Group 8 – Displacement encoder error
CPX error group 108 (CPX-MMI: [Encoder error])

No.	Message		Malfunction level	Reset type
85	**Operating voltage of displacement encoder/sensor interface outside the tolerance range** Operating voltage of displacement encoder/sensor interface outside tolerance		F2	F
	Cause Measure	Operating voltage of the displacement encoder too low. • Check power supply. • Check lines on the axis string.		
87	**Defective displacement encoder cable or potentiometer in electrical end position** Defective displacement encoder cable or potentiometer in electrical end position		F2	N
	Cause Measure	Defective displacement encoder cable. • Check power supply. • Check lines on the axis string. • Switching off/on may be required. • If this occurs repeatedly, replace the displacement encoder or sensor interface.		
	Cause Measure	Displacement encoder in the electrical end position (potentiometer only). • Move displacement encoder (potentiometer) from the end position.		
89	**Faulty data content in the displacement encoder/sensor interface** Incorrect data content in the displacement encoder/sensor interface		F2	N
	Cause Measure	The displacement encoder/sensor interface contains incorrect or contradictory data. • Switch the power supply off and then on again. If the error is signaled again: • Replace displacement encoder/sensor interface. • Check compatibility of the displacement encoder/sensor interface with the firmware version of the CMAX.		

4.3 Diagnostic parameters

4.3.1 Latest diagnostic status

The CMAX offers various parameters for the current diagnostic messages.

PNU	Brief description
220	Active error messages, bit-coded
221	Active warning messages, bit-coded
224	Currently indicated message “Exx” on the display
225	Currently active step
226	Current warning to be displayed in FCT
227	Error status, bit-coded for FCT

Tab. 4.6 Diagnostic parameters

Parameter	Description		
Bit-coded messages PNU 220 PNU 221	Each parameter is a bitfield consisting of three uint32 values and thus contains 3x 32 bits = 96 bit memory capacity. Each of these bits in this array represents an error number. If it is set, the corresponding error message is active.		
	Example:		
	PNU 220:01 = 0x00000001	Bit 0 set	E01 active
	PNU 220:02 = 0x00000040	Bit 38 (32+ 6) set	E39 active
	PNU 220:03 = 0x00030000	Bit 80 (32 + 32 + 16) set	E81 active
		Bit 81 (32 + 32 + 17) set	E82 active
	This representation is optimized for evaluation by a higher-order controller, since this bit coding can be used directly to activate an MMI. PNU 220: contains current errors PNU 221: contains current warnings		
Message on the display PNU 224 PNU 226	The PNU 224 contains the error number currently being shown on the display. This makes synchronisation between the display in the FCT and the CMAX possible. The message that occurred first is always displayed. The PNU 226 contains the warning number the FCT is supposed to display. The warning is not shown on the CMAX display.		
Active level PNU 225	With this, FCT can display the current status of the CMAX corresponding to the level of the error or warning (➔ Section 4.2.1). The most serious currently reported error is always responsible for the current level.		
Bit-coded error status PNU 227	The bit-coded error status allows the FCT to indicate the exact status of an active error message. The coding is identical to the coding of the additional information in PNU 203. Description (➔ Section 4.3.3).		

Tab. 4.7 Parameters of the diagnostic memory

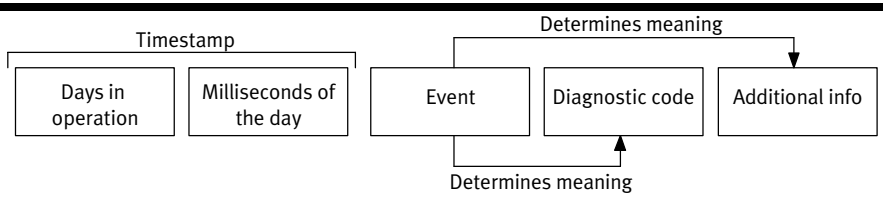
4.3.2 Diagnostic memory

The diagnostic memory contains the diagnostic messages of the last 100 events that occurred. The memory is backed up in the event of a power failure. If the buffer is full, the oldest element will be overwritten. When reading, the newest entry is read first (LIFO principle).

Number (subindex)	Diagnostic memory entry
1	Newest (last) diagnostic message
2	Next-to-last diagnostic message
...	...
100	Oldest diagnostic message

Tab. 4.8 Structure of the diagnostic memory

Structure of an entry in the diagnostic memory



PNU 222	PNU 202	PNU 200	PNU 201	PNU 203
int32	int32	int32	int32	int32, (bit-coded)
Number of days in operation	Number of milliseconds of the day	Diagnostic event	Diagnostic code	Additional information for FCT

Tab. 4.9 Structure of diagnostic memory entry

Which entries are recorded in the diagnostic memory can be configured with PNU 228 ➔ Section 4.4.

Parameter	Description
Timestamp PNU 202 PNU 222	Time of the diagnostic event since the delivery status, reset device data or firmware download in milliseconds. – PNU 222 contains the number of days – PNU 202 contains the number of milliseconds of the day The timestamp is not a real-time clock: The time is read from the device data (PNU 140) when the message occurs. The CMAX counts the period of operation. The current time (➔ PNU 140) is saved during switch-off and loaded again during switch-on.
Diagnostic event PNU 200	Type of diagnostic message. Not only errors and warnings are entered into the diagnostic memory, but also switch-on operations, resets or configuration events. The interpretation of the diagnostic code and the additional information depends on the type of these events.
Diagnostic code PNU 201	The diagnostic code includes detail on the diagnostic event. For errors and warnings, this is the exact number, while for configuration events it is the function performed, etc.
Additional information PNU 203	Detailed information on the diagnostic event. The evaluation is complex and therefore suitable for a control program under limited conditions only. Description ➔ Section 4.3.3.

Tab. 4.10 Parameters of the diagnostic memory

Diagnostic events

The diagnostic event determines the meaning of the diagnostic code and the additional information.

Diagnostic events (PNU 200)				
Value [1]	No.	Description	Diagnostic code (PNU 201)	Additional information (PNU 203)
0	–	Blank entry	–	–
1	E...	Errors	Error number ➔ 4.2.4	Additional information, error
3	R...	Reset	Reset number ➔ 4.3.4	Additional reset information
5	W...	Warning	Warning number ➔ 4.2.4	Additional warning information
7	P...	Switch-on	Switch-on information ➔ 4.3.4	Additional switch-on information
8	C...	Configuration	Configuration information ➔ 4.3.4	Additional configuration information

1) Other values are reserved

Tab. 4.11 Values of the diagnostic events with assignment to diagnostic code and additional information

Depending on the event, the FCT can provide detailed information on the respective entry with the help of the additional information.

Examples of diagnostic messages in the FCT			
Timestamp	Event	No.	Description
2817d 17h 21,123s	Reset	R01	Reset successfully executed. All messages have been deleted. No more errors are present.
2817d 16h 18,123s	Errors	E50	Operating pressure too low (< 1.5 bar) Last command: Execute record, record number 64
+2817d 03h 18,123s	Switch-on	P01	Project data available and loaded (duration of initialization: 1289 ms). Number of switch-ons since last diagnostic entry: 219
117d 03h 18,123s	Configuration	C05	Static and dyn. identification executed. Duration: 178 s. Identification was successful.

Tab. 4.12 Examples of diagnostic events

PNU 204: Administration of the diagnostic memory	
Index	Description
1, 2	Reserved
3	– Writing of 1: diagnostic memory is deleted. – Reading always delivers the value 0. Deleting is usually not required (ring buffer, when the memory is full, the new entry overwrites the oldest).
4	Number of valid entries. Writing is not permitted.
5	Number of unread entries. With every new entry into the diagnostic memory, the value is increased by 1. Can be set to 0 in the PNU.

Tab. 4.13 Administration of the diagnostic memory

4.3.3 Error status and additional information

This additional information is designed mainly for diagnostics performed by FCT. The additional information supplements the error number by adding helpful information, such as the record number. With active messages, it also indicates whether the error can be acknowledged and whether the cause is still active. The coding is the same for the parameters:

– PNU 203: Additional information for messages in the diagnostic memory. Index 1 ... 100 corresponding to the entry number
– PNU 227: Coding of the current status of a message. Index 1 ... 89 corresponding to the error or warning number

Since several errors or warnings may be pending simultaneously, the information of the PNU 227 needs to be available for every number separately. Therefore, when querying, the number must be specified as the index.

Allocation of the additional information for errors and warnings																															
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Internal diagnostic code										A	S	Reset				Level				Informa-tion				Details							

Tab. 4.14 Additional info

The coding is the same for PNU 203 and 227, but it only contains the information that is useful and available for the respective parameter.

Area	Name	Description
Bit 31...22 (PNU 203 / --)	Internal diagnostic code	Internal diagnostic information (only for service staff).
Bit 21 (-- / PNU 227)	A	**Required action** = 0: Acknowledge: The cause of the message is currently not active or is not being checked at the moment. The message can be acknowledged. = 1: Eliminate: The cause of the message is still active. The cause must be resolved before the message can be acknowledged. Note: In the event of errors with reset type Poff (bit 19 ..16), switching on/off is always required independently of the status of bit 21.
Bit 20 (-- / PNU 227)	S	**Status of the error message** = 0: The message is currently not active. = 1: The message is active
Bit 19...16 (PNU 203 / PNU 227)	Reset type (➔ 4.2.2)	**Describes what happens in the event of a reset command.** = 0: No reaction = 1: R = Delete error message(s) = 2: F = Delete error message if the cause has been eliminated = 3: N = Initialize the axis again = 4: Poff = Switch off CMAX
Bit 15...12 (PNU 203 / PNU 227)	Level (➔ 4.2.1)	**Describes the reaction to the fault or warning** = 0: None = 1: Information (ignore message) = 2: W = Warning = 5: F1 = Fault 1 = 6: F2 = Fault 2 = 15: FS = system fault
Bit 11...8 (PNU 203 / --)	Information	**Describes what the details refer to** (➔ Tab. 4.16)
Bit 7...0 (PNU 203 / --)	Details	**Additional details on the cause of the message** (➔ Tab. 4.16)

Tab. 4.15 Allocation of the additional information for faults and warnings

Information and details on the messages (PNU 203)			
Info (bit 11 ... 8)		Details (bit 7... 0)	
Value	Description	Value	Description
0	No information	–	–
1	Cause of warning W08 (Cylinder, valve or sensor interface were exchanged)	1	Not specified
		2	Valve was exchanged
		3	Cylinder was exchanged
		4	Cylinder, displacement encoder or sensor interface was replaced
2	Cause of fault E09 (faulty parameter in the project)	1	Not specified
		2	A required parameter is not configured (supply pressure, base load, control parameter)
		3	The measuring system type does not match the cylinder type
		4	The cylinder length does not match the cylinder type
		5	The measuring system length does not match the cylinder type
		6	The measuring system length must be the same as the cylinder length with this cylinder type
		7	Offset axis zero point is not permissible for this cylinder (must be 0)
		8	The offset axis zero point is defective Permitted range: -Cylinder length ≤ offset ANP ≤ 0
		9	The cylinder diameter does not match the cylinder type
		10	The piston rod diameter does not match the cylinder type
		11	Two different valves were configured
		12	The lower software end position is smaller than the lower hardware end position
		13	The upper software end position is larger than the upper hardware end position
		14	The lower software end position is larger than or the same size as the upper software end position

Information and details on the messages (PNU 203)			
Info (bit 11 ... 8)		Details (bit 7... 0)	
Value	Description	Value	Description
3	Cause of fault E44 (teaching not possible)	1	Not specified
		2	In direct operation, it is not possible to teach (no teach target present)
		3	Homing not executed
		4	Commissioning: Unknown teach target specified in parameter 1
		5	Record mode: Invalid record number (0 or › 64)
		6	Record mode: Invalid control mode preset in the selected record
		7	Commissioning: Teaching lower software end position ≥ upper software end position not permissible
		8	Commissioning: Teaching upper software end position ≤ lower software end position not permissible
		9	Commissioning: Teaching is not permissible while a commissioning operation is being executed
		10	Change of operating mode while teaching is active (CPOS.TEACH=1)
4	Record number	nn	In the event of a general fault in record mode, the number of the last record started is entered. Value range nn: 0 to 255
5	Commissioning function	nn	1 = Identification 2 = Movement test

Information and details on the messages (PNU 203)			
Info (bit 11 ... 8)		Details (bit 7... 0)	
Value	Description	Value	Description
6	Drive function in which the fault occurred	1	Switch on
		2	Enable drive
		3	Disable drive
		4	Enable operation
		5	Disable operation (stop)
		10	Direct mode start
		11	Direct mode start positioning command
		12	Direct mode start force command
		13	Direct mode start continuous positioning command
		14	Direct mode start continuous force command
		20	Start homing
		21	Start homing method 35 (current actual position)
		22	Start homing mode method 17 (positive against block)
		23	Start homing method -18 (negative against block)
		30	Jog mode in negative direction (CPOS.JOGN)
		31	Jog mode in positive direction (CPOS.JOGP)
		32	Teach
		33	Teach setpoint value in record table
		34	Teach lower software end position
		35	Teach upper software end position
		36	Teach offset project zero point
7	Cause for fault E58 (handshake fault)	1	Detailed information not available
		2	2 CPOS.START set with operation enable
		3	CPOS.HOME set with operation enable
		4	Rising edge at CPOS.START although SPOS.ACK=1
		5	Rising edge at CPOS.HOM although SPOS.ACK=1
		6	Rising edge at CPOS.JOGP although SPOS.ACK=1
		7	Rising edge at CPOS.JOGN although SPOS.ACK=1
		8	CPOS.JOGP set with operation enable
		9	CPOS.JOGN set with operation enable
		10	Simultaneous start of multiple positioning commands

Tab. 4.16 Information and details for faults

4.3.4 Diagnostic code and additional information with reset, switch on and configuration

The diagnostic memory contains other diagnostic events besides faults and warnings.

Diagnostic event 3: reset

A reset command was executed with FCT or with the higher-order controller.

Diagnostic code (PNU 201)	
No.	Description
1	Successful: All messages have been deleted
2	Not successful: Not all messages could be deleted
3	Restart of the axis has been performed

Additional information (PNU 203)	
Information	Description
Byte 1	Number of resets so far[1)]
Byte 2	Reserved
Byte 3 + 4	Reset duration in milliseconds after restart of the axis

1) Resets executed one after another are combined into one entry

Diagnostic event 7: switch-on

The CMAX has been switched on.

Diagnostic code (PNU 201)	
No.	Description
1	Normal start: project data fully loaded
2	Start in configuration mode C00: no project present
3	Start in configuration mode C01: project incomplete
4	Start in configuration mode C02: project incomplete
5	Start in configuration mode C03: Movement test must be carried out

Additional information (PNU 203)	
Information	Description
Byte 1	Number of switch-on processes since the last message[1)]
Byte 2	Reserved
Byte 3 + 4	Duty cycle in milliseconds

1) Switch-on procedures executed one after another are combined into one entry

Diagnostic event 8: configuration

A configuration/commissioning operation was executed.

Diagnostic code (PNU 201)	
No.	Description
1	Firmware was updated
2	Data reset: All user and controller data was deleted
3	Movement test was carried out
4	Identification was executed (static)
5	Identification was executed (static and dynamic)
6	Identification was reset, identification data were deleted

Additional information (PNU 203)	
Information	Description
Byte 1	= 1: Successfully carried out = 2: Execution cancelled
Byte 2	Reserved
Byte 3 + 4	Duration of the function in 0.1 seconds

4.4 Parameterisation of diagnostic messages

PNU 228 permits parameterisation of diagnostic events.

PNU 228: Parameterisation of diagnostic events		
Index	Description	Default
1	Diagnostic events filter	0x0000000F
2	Errors and warnings filter	0x0000007F
3	Messages	0x000000C0

Tab. 4.17 Parameterisation of the diagnostic messages

Diagnostic events filter

The filter determines which diagnostic events are recorded. PNU 228:01 allows you to exclude specific less important events from the diagnostic memory records.

PNU 228:01: Diagnostic events filter Which events other than faults should be recorded?		
Bit	**Description**	**Default**
0	Record warnings	1
1	Record configuration events (data reset, identification etc.)	1
2	Record reset commands	1
3	Record switch-on processes	1
4 ... 31	Reserved (=: 0)	0

Tab. 4.18 Parameterisation of the diagnostic messages – diagnostic events filter

Errors and warnings filter

This error and warnings filter allows you to exclude certain errors and warnings from being recorded in the diagnostic memory. This makes sense for errors or warnings that are part of the normal operating cycle because they are inherent to the process (load voltage errors) or because they occur frequently for other reasons.

Attention: Even if these messages are not entered in the diagnostic memory, the respective error in the corresponding situation must be reported and acknowledged.

PNU 228:02 – Errors and warnings filter
Should this error / warning be entered in the diagnostic memory?

Bit	Description	Default
0	W08: Cylinder, valve or sensor interface were exchanged	1
1	E35/w35: Software end positions travelled over	1
2	W42: Reserved control bits set	1
3	E50/W50: Operating pressure is too low	1
4	E51: Load voltage of the controller outside of the tolerance range (under-voltage)	1
5	W57: Timeout diagnostic interface: FCT device control has been deactivated	1
6	W68: Preliminary warning valve over-temperature	1
7 ... 31	Reserved (=: 0)	0

Tab. 4.19 Parameterisation of the diagnostic messages – messages filter

Setting error characteristics
Some errors can also be reported as warnings. This concerns, in particular, function monitoring, such as maintaining the software end positions. The correct reaction in these cases often depends on the application.
For messages where both reactions are possible, the behaviour of the CMAX can be determined. Not all messages can be parameterised individually, but only selected ones for which parameterisation makes sense.

PNU 228:03 – Setting error characteristics
Which errors should be treated as warnings?

Bit	Description	Default [1)]
0	E27: Step enabling condition cannot be reached during the positioning command. If warning: Record is executed as if no record sequencing were parameterised. Subsequent record is not executed, error E28 is not reported.	0
1	E28: Step enabling condition was not reached. If warning: The CMAX stops in the record whose sequencing condition was not reached.	0
2, 3	Reserved (=: 0)	0
4	E32: Target force outside the force limits. If warning: If exceeded, the target force is restricted to the limit value by the CMAX.	0
5	E33: Target position outside the software or hardware end positions. If warning: If the target position is larger than the software end position, the software end position or the hardware end position (with deactivated software end positions) is approached.	0

1) 0 = The message is treated as an error; 1 = The message is treated as a warning

PNU 228:03 – Setting error characteristics Which errors should be treated as warnings?		
Bit	**Description**	**Default [1)]**
6	E34: Setpoint value of tracking mode outside of the limit values. If warning: The setpoint value (position or force) is taken over only up to the limit values. The axis stops at the software end position or force limit. Positioning is not cancelled. If the setpoint value is smaller than the limit value, the CMAX will track the axis.	1
7	E35: Software end position passed. If warning: The axis does not stop and continues to execute the positioning command (does not apply to force control).	1
8	E50: Operating pressure is too low. If warning: The CMAX behaves as if there were sufficient pressure. Positioning commands lead to error E30 or E31.	1
9	E58: Start not allowed with operation enable	0
10 ... 31	Reserved (=: 0)	0

1) 0 = The message is treated as an error; 1 = The message is treated as a warning

Tab. 4.20 Parameterisation of the diagnostic messages – parameterisation of messages

4.5 Diagnostics via standard functions of the CPX terminal

Errors and warnings of the CMAX or the connected modules are reported to the bus nodes as CPX error messages. The following sections contain the special features of the representation for the CPX-specific diagnostics options.

– Module I/O data (control and status bytes ➔ Section 2.2
– Status bits ➔ Section 4.5.1
– I/O diagnostics interface ➔ Section 4.5.2

4.5.1 Status bits of the CPX terminal

Tab. 4.21 shows error messages of the CMAX in the status bits of the CPX terminal.

Bit	Diagnostic information with logic 1	Description	CMAX cause of error
0	Error at valve	Module type in which an error has occurred	–
1	Error at output		–
2	Error at input		–
3	Error at analogue module/ technology module		Bit 3 is set for all errors of the CMAX.
4	Undervoltage	Error type	–
5	Short circuit/overload		–
6	Wire break		–
7	Other error		–

Tab. 4.21 Overview of status bits

4.5.2 I/O diagnostic interface and diagnostic memory

A range of different diagnostics information is accessible via the I/O diagnostics interface and the diagnostic memory of the CPX terminal.

Diagnostic memory data (CPX-MMI and I/O diagnostics interface)

The representation of diagnostic messages of the CMAX in the diagnostic memory of the CPX terminal occurs as shown in Tab. 4.22.

Diagnostic memory data (10 bytes per entry, max. 40 entries)				**Function no. 1)**
Byte	Designation	Description	Value	3488 + n
1 2 3 4 5	Days [day] Hours [h] Minutes [m] Seconds [s] Milliseconds [10 ms]	Time specification of the reported error, measured from the point when the power supply is switched on (CPX standard).	0 ... 255 0 ... 23 0 ... 59 0 ... 59 0 ... 999 (128...227)	n = 10 * d + 0
6	Module code	Module code of the CMAX: 176	0 ... 255	n = 10 * d + 5
7	Module position [Pos]	Module number of the CPX module that signaled the error.	0 ... 47	n = 10 * d + 6
8	Channel number	**Bit 7 6 5 ... 0 description** 1 0 0 ... 0 Error in I-channel 1	128 (0 ... 255)	n = 10 * d + 7
9	Error number [FN]	CPX error number (➔ Section 4.2.3)	90 ... 99 (0 ... 255)	n = 10 * d + 8
10	Following channels	Always 0 for the CMAX	0 (0 ... 63)	n = 10 * d + 9

1) d (diagnostic event) [NB] = 0 ... 39 ; most current diagnostic event = 0

Tab. 4.22 Diagnostic memory data of the CMAX

Notes on diagnostics with the I/O diagnostics interface ➔ CPX system description.

Example of diagnostic memory entry for error E50

Diagnostic memory data			**Value**	
Byte	**Designation**	**Description**	**Dec**	**Hex**
1 2 3 4 5	Days [day] Hours [h] Minutes [m] Seconds [s] Milliseconds [10 ms]	Error was reported 22.66 ms after the power supply was switched on (bit 7 in byte 5 is set if this is the first entry since Power ON).	0_d 0_d 0_d 22_d 194_d	00_h 00_h 00_h 16_h $C2_h$
6	Module code	Module code of the CMAX: 176	176_d	$B0_h$
7	Module position [Pos]	In this case, the CMAX is CPX module No. 2.	2_d	02_h
8	Channel number	**Bit 7 6 5 ... 0 Description** 1 0 0 ... 0 Error on axis 1	128_d	80_h
9	Error number [FN]	CPX error number: 105	105_d	69_h
10	Following channels	Always 0 for the CMAX	0_d	00_h

Tab. 4.23 Example of diagnostic memory entry

Diagnostic data of the module (I/O diagnostic interface)

The specific representation of module diagnostic data (error messages) of the CMAX occurs as shown in Tab. 4.24 and Tab. 4.25.

Module diagnostic data: type of error and location of the error	
Function no.	2008 + m * 4 + 0; m = module number (0 ... 47)
Description	Describes where the relevant error occurred.
Values	**Bit 7 6 5 ... 0 : Description** 1 0 000000 : Error in I-channel 0 (axis 1)

Tab. 4.24 Type of error and location where error arose

Module diagnostic data: module error number	
Function no.	2008 + m * 4 + 1; m = module number (0 ... 47)
Description	Error number
Values	100 ... 108 CPX error number, (➔ Example Tab. 4.23)
Note	Error messages of the CMAX (➔ Section 4.2.3).

Tab. 4.25 Module error number

4.5.3 Parameterisation via the I/O diagnostic interface

In principle, parameters can also be changed via the CPX bus nodes or CPX-FEC-specific functions, such as acyclic services, etc. The CMAX parameters are accessed via the I/O diagnostic interface (➔ Tab. 4.26).

Information on the parameterisation ➔ Description of the CMAX communication profile.

Function number [1]	**Parameter entry**
4828 + m*64 + 0 ... 5	Reserved (standard module parameters, not used by the CMAX)
4828 + m*64 + 6	Reserved for special module settings of the CMAX
4828 + m*64 + 7	
4828 + m*64 + 8 ... 11	Task control
4828 + m*64 + 12 ... 61	50 byte data (depending on the task).
4828 + m*64 + 62, 63	Reserved

1) m = Module number

Tab. 4.26 I/O diagnostics interface

Additional information

Module diagnostic data: module code	
Function no.	16 + m*16 + 0; m = module number (0 ... 47)
Description	CPX module code
Values	176 = CPX-CMAX-C1-1

Tab. 4.27 Module code

Module diagnostic data: revision code	
Function no.	16 + m*16 + 13; m = module number (0 ... 47)
Description	Version of the module corresponding to the rating plate.
Values	0 ... 255

Tab. 4.28 Revision code

After a firmware update, the rating plate and the version no longer match.

Module diagnostic data: serial number	
Function no.	784 + m*4 + 0; m = module number (0 ... 47) 784 + m*4 + 1 784 + m*4 + 2 784 + m*4 + 3
Description	Specifies the serial number of the module (4 bytes, uint32).
Values	0 ... 255

Tab. 4.29 Serial number

5 Parameterisation

5.1 Overview of parameterisation possibilities

Access/function	Access via	Detailed description
Local with PC (e.g. during commissioning)	FCT with CMAX plug-in	Help for the CMAX FCT plug-in
Higher-order controller via I/O data	FPC in the module input and output data	Section 5.4

Tab. 5.1 Parameterisation possibilities

5.2 Access protection

5.2.1 Password protection

The password protection prevents unauthorised controlling or modifying of parameters in a producing system. The password only prevents write access - reading is always possible.
There are 2 possibilities to modify parameters:
– via the diagnostic interface with a PC with FCT,
– via fieldbus through the operating higher-order controller (I/O data in parameterisation mode),
You can assign a password for the diagnostic interface in the CMAX. Modifications are always possible via fieldbus. When starting up the device for the first time (delivery status), there is no password in the device.
Blocked are the modification of parameters and control of inputs, start, stop, teaching and firmware download. Permissible is the display of parameters, project upload, display of actual values, setpoint values, diagnostic data.
The following parameters can be modified despite password protection:

PNU	Parameter	Description of the reason
116	Project identifier	Reserved for the FCT (synchronisation status)
130	Password	Must be writeable
133	System password	Reserved for the FCT (reset CMAX in the event of “Forgot password”)
204:05	Number of new entries	Diagnostic memory display (status value, no parameter in the plug-in)
1173:01	Limit value status	For display of the limit values (status value, no parameter in the plug-in)

Tab. 5.2 Parameters that can be written without password

Creating a password with FCT

The password protection can be created with the CMAX FCT plug-in with existing online connection with the menu command [Component] [Password] ➔ Help on the CMAX FCT plug-in.
The password must then be entered when connecting with the FCT for the first time. It then remains active until the project is closed in the FCT.
To change it, first enter and delete the old password. Then the new password can be entered and accepted.

Determination of a password with the higher-order controller

PNU 130 includes the password as string. The parameter PNU 1192:04 controls the acceptance and delivers the current status. To define a password for the CMAX:

1. Write the password in PNU 130, e.g. PNU 130 =“My_password”.
2. Accept the password into the device data by setting PNU 1192:04 = 1.

The password is implemented as a string in CMAX and consists of 8 bytes (ASCII code: 32 to 127).

PNU 1192:04 Accept password	
Access	Values
Write	= 0: Delete a password
	= 1: Accept password
Read	= 0: No password set
	= 1: Password set and access free
	= 2: Password set and access blocked

Tab. 5.3 Password access control

The password cannot be read or reset. If you forget the password, the CMAX can be completely reset. This not only deletes the axis data but also the device data. This reset can only be performed by FCT, not via the controller.

5.2.2 Access with higher-order controller and FCT

Simultaneous operation of the drive through the higher-order controller and FCT can be locked. This is done with the bits CCON.LOCK (FCT access blocked) and SCON.FCT (FCT device control).

Prevent FCT operation: CCON.LOCK

By setting the CCON.LOCK, the higher-order controller can prevent the FCT from taking over the device control. Then FCT cannot write parameters nor control the drive.
The controller should be programmed not to issue this release until the user carries out a corresponding action. This generally causes exit from automatic operation. This means that the controller programmer can ensure that the controller always knows when it has control over the drive.
The lock is active if the CCON.LOCK has logic 1.

To permit access to components through various authorisation stages, CCON.Lock blocks further functions in firmware design 2.2 and higher.

Access permitted	Access not permitted
Read diagnostic memory	Change parameters
Read current error or warning	Carry out data reset
Read actual and setpoint values	Perform restart
Perform trace	Acknowledge error/warning present

Tab. 5.4 Access with CCON.LOCK = 1

The following parameters can be modified despite CCON.LOCK = 1:

PNU	Parameter	up to FW 1.9	from FW 2.2
116:01 ... 33	FCT project identification	Yes	No
121:01 ... 30	User's device name	Yes	No
130:01 ... 30	Password	Yes	Yes
133:01 ... 02	System password	Yes	No
204:05	Number of unread entries	Yes	No
407:01 ... 64	Acceleration record	Yes	No
408:01 ... 64	Deceleration record	Yes	No
410:01 ... 64	Payload record	Yes	No
1150:01	Position controller: amplification gain	Yes	No
1151:01	Position controller: cushioning factor	Yes	No
1152:01	Position controller: filter factor	Yes	No
1160:01	Force controller: amplification gain	Yes	No
1161:01	Force controller: dynamic amplification	Yes	No
1162:01	Force control: filter factor	Yes	No
1173:01	Limiting values: status	Yes	Yes
1192:04	Commissioning operations: password status	Yes	No

Tab. 5.5 For CCON.LOCK = 1 writeable parameters

Acknowledgment of master control with FCT: SCON.FCT
SCON.FCT indicates that the drive is controlled by the FCT and that no control over the drive is possible via the I/O data. The higher-order controller can react by moving to stop or manual operation.

5.2.3 Status-dependent and operating-mode-dependent block

This lock is designed to protect against operational errors during the operating phase. It is not permissible to modify parameters during operation that affect the controller. To do this, you must change to commissioning mode (or parameterisation, when using the cyclical I/O data). This data is documented as commissioning data. Each parameter also states which operating status is needed.
To write a commissioning parameter
– The “commissioning” or “parameterisation” operating mode must be active
– The drive must be locked (CCON.ENABLE = 0)

5.2.4 Enable and stop with parameterisation

Parameterisation in the cyclical I/O data can only be performed if the CMAX is not in the “Operation enabled” status (CCON.ENABLE = 0). Commissioning parameters require that the controller is locked when writing.
For transfer of parameters, CCON.STOP and CCON.ENABLE must be set as described.

Operating mode	**Read: CCON**[1)]		**Write: CCON**[1)]	
	.ENABLE	**.STOP**	**.ENABLE**	**.STOP**
Record mode	x	x	x	x
Direct mode	x	x	x	x
Commissioning	x	x	0	x
Parameterisation	x	0	0 / x [2)]	x / 0 [2)]

1) x = without effect on the parameterisation
2) For commissioning parameters, CCON.ENABLE = 0 must be set, while CCON.STOP can have any status

Tab. 5.6 Effect of the parameter transfer to CCON

5.3 Global default values

Global default values can be used to globally specify positioning parameters (speed, acceleration, tolerance, ...). The global default values then replace the individual parameters for a positioning command in record mode, direct mode, homing or jogging.

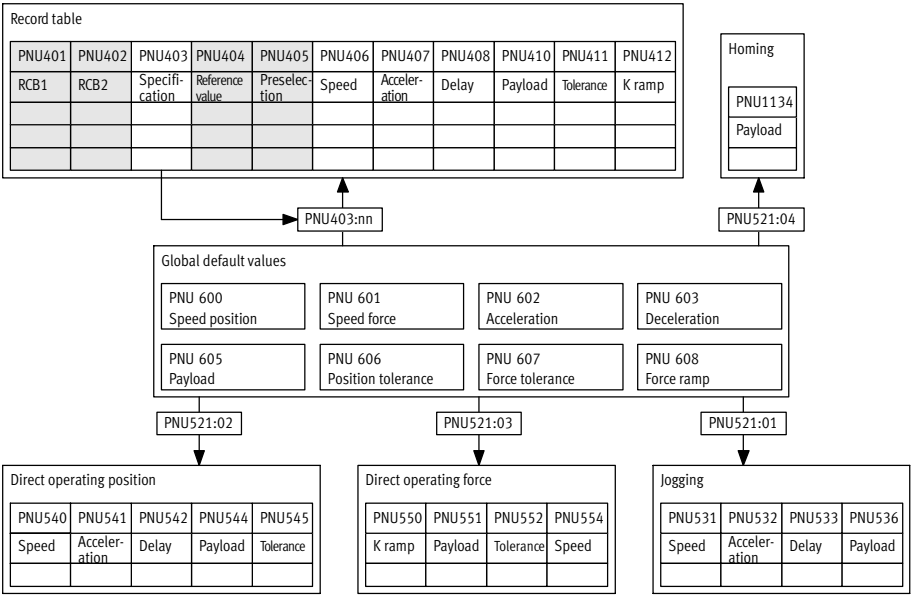


Fig. 5.1 Effect of the global default values

If, for example, the same velocity is to be used for each record in an application, it is not necessary to enter the same value in the position list each time. Instead, the record table refers to the default value. In order to use values other than the default values in an individual record, you only need to specify the values for the record parameter in this one record.

Benefits:

– Simplifies parameterisation.
  The record and direct operating parameters are by default defined so that the global default values are used instead of the parameters. If the global default values are used for the parameters speed, acceleration, deceleration, payload and tolerance, this amounts to 5 x 64 = 320 parameters for 64 records that do not need to be entered.
– Increased data transmission performance.
  Since less data is transmitted, the time required for parameterisation is reduced. This affects serial connections, such as with the FCT, but also fieldbus connections.

When is a global default value used?

For each parameter, a flag defines whether the global default value is used. If you want the value from the record or the special parameter to be used, the flag needs to be set to 1. Otherwise the default value will be used. The following parameters contain flags for global default values:

Positioning type	PNU	Index	Parameter
Record mode	403	nn (record no.)	Record default value
Jogging	521	01	Jogging default value:
Direct operating position	521	02	Direct mode position default value
Direct mode force	521	03	Direct mode force default value
Homing	521	04	Homing default value

Tab. 5.7 Control of the global default values

Parameter control		
Bit	**PNU 403: record default values**	**PNU 521: jog mode, direct mode, homing default values**
31	= 0: Record is blocked = 1: Record is active	Not evaluated
30	= 0: Record is not initialised or deleted = 1: Record is initialised by user	Not evaluated
0 ... 29	Bit field, controls acceptance of the default values (➔ Tab. 5.9). = 0: Use the default values = 1: Use the parameter from the record table or the data for the direct mode	

Tab. 5.8 Flag for the parameter control

Parameters used depending on the bit status							
Bit	**Parameter**	**Bit = 0**	**Bit = 1**				
			Record mode	Jogging	Position direct mode	Force direct mode	Homing
0	Speed, position	600	406	531[1)]	540	–	–
1	Force speed	601	406	–	–	554	–
2	Acceleration	602	407	532[1)]	541	–	–
3	Deceleration	603	408	533[1)]	542	–	–
4	– (reserved)	–	–	–	–	–	–
5	Payload	605	410	536	544	551	1134
6	Position tolerance	606	411	–	545	–	–
7	Force tolerance	607	411	–	–	552	–
8	Force ramp	608	412	–	–	550	–
9 ... 29	– (reserved)	–	–	–	–	–	–

1) FCT permits no default values 600, 602, 603 for jogging, only the special values 531, 532 and 533 ➔ Fig. 5.1.

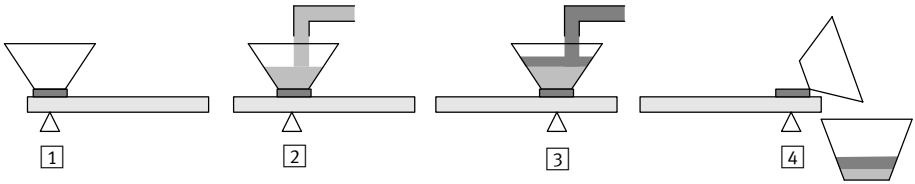
Tab. 5.9 Parameters used

How is evaluation performed?

Evaluation is performed upon start. When using the free profile, the CMAX checks for each setpoint value parameter whether it should use the global default setting or the individual parameter. Individual parameter values should be used if the corresponding bit is set to 1 in default values record (PNU 403) or default values jogging and direct mode (PNU 521).

Example

Two types of bulk goods are to be brought to a collection point and emptied there.



1 Position 1: 20 mm (“Wait”)
2 Position 2: 75 mm (“Load 1”)
3 Position 3: 145.50 mm (“Load 2”)
4 Position 4: 205.20 mm (“Empty”)

Fig. 5.2 Example of different mass loads

Step	Exercise
1	Waiting in a waiting position to start collecting the bulk goods. Upon start, the empty slide uses the global default values to travel from the starting position 1 to the first loading position 2.
2	With increased mass load (12 kg), the slide travels to the second load position 3. But acceleration and speed may correspond to the global default values.
3	The full container (25 kg) is moved to the unloading position 4. Here the slide needs to travel based on reduced speed and acceleration values due to the full container.
4	From the unloading position 4, the slide can return to the initial position 1 at full speed.

Tab. 5.10 Example of global default values: steps

To perform this task, the following global default values are defined first. Force control is not required; the values are not taken into account.

Parameter	PNU	Value		Comment
Speed	600	1000	(= 1 m/s)	Do not use the maximum possible values from the identification data.
Acceleration	602	1000	(= 1 m/s^2)	
Brake ramp	603	1000	(= 1 m/s^2)	
Payload	605	0	(= 0 kg)	No payload in the normal status
Tolerance	606	50	(= 0.5 mm)	Tolerance = 0.5 mm

Tab. 5.11 Example of global default values: steps: setting default values

Record table: All blank fields in the record table do not need to be parameterised explicitly. The record control bytes 1+2 can be used as preset.

Record no.	RCB1	RCB2	Default (Low word)	Reference value	Preselection	Speed	Accel.	Deceleration	Payload	Tolerance	Force ramp
			↳			Bit 0 0001h	Bit 2 0004h	Bit 3 0008h	Bit 5 0020h	Bit 6 0040h	Bit 8 0100h
1			C000 0000$_h$	7500							
2			C000 0020$_h$	14550					120		
3			C000 002D$_h$	20520		400	200	200	250		
4			C000 0000$_h$	2000							

Tab. 5.12 Example of global default values: record table

With this record table and the global default values, the drive in fact performs the following movement:

Step	Start	Target	Speed	Acceleration	Deceleration	Payload	Tolerance
1	20.0 mm	75.0 mm	1.0 m/s	1.0 m/s^2	1.0 m/s^2	0.0 kg	0.5 mm
2	75.0 mm	145.5 mm	1.0 m/s	1.0 m/s^2	1.0 m/s^2	12.0 kg	0.5 mm
3	145.5 mm	205.2 mm	0.4 m/s	0.2 m/s^2	0.2 m/s^2	25.0 kg	0.5 mm
4	205.2 mm	20.0 mm	1.0 m/s	1.0 m/s^2	1.0 m/s^2	0.0 kg	0.5 mm

Tab. 5.13 Example of global default values: executed movements

5.4 Festo Parameter Channel (FPC)

The FPC is used for transmitting parameters. The higher-order controller sends a request to the CMAX consisting of a parameter number, subindex, value and task identifier. The CMAX responds with the PNU, subindex, value and a response identifier. This process takes several bus cycles.
After switch-over into the parameterisation operating mode, the FPC occupies the control and status bytes of the CMAX ➔ Section 2.2.6.

FPC								
	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Task	CPOS	Subindex	Parameter identifier		Parameter value			
Answer	SPOS	Subindex	Parameter identifier		Parameter value			

Tab. 5.14 Structure of FPC

Parameter identifier																
Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Task	Request identifier				Parameter number											
Answer	Response identifier				Parameter number											

Tab. 5.15 Structure of parameter identifier

Component	**Abbreviation**	**Description**
Parameter identifier	ParID	16 bit identifier, consisting of ReqID/ResID and parameter number.
Request identifier	ReqID	Request identifier - task identifier: Read value, change value, ...
Response identifier	ResID	Response identifier: transfer value, fault, ...
Parameter number	PNU	Parameter number - for addressing a parameter.
Subindex	IND	Subindex - for addressing an array component.
Parameter value	Value	Parameter value (in the event of an error, the error number as a response).

Tab. 5.16 FPC components

5.4.1 Task identifiers, response identifiers and error numbers

Description	ReqID Task	ResID (+) with response	ResID (–) with error
No job	0	0	0
Read parameter value	6	5	7
Change parameter value	8	5	7

Tab. 5.17 Request identifiers and response identifiers

Rules:
- There are the data types integer, character (char) and bitfield.
- Each parameter value is transmitted as a 32-bit value.
- A string is an array of characters that can only be transmitted individually via the cyclic channel. The value NUL (=0x00) is interpreted as the string end. A higher-order controller must always transmit the zero as the last character.
- Simple variables have no subindex.
  The transmitted subindex can have the values 0 and 1. The value 0 corresponds to “not used”. It is recommended to set the subindex to 1 as if the parameter were an array with a component. Values › 1 are rejected with error 3.

Faults	Error description
0	Non-permitted PNU
1	Parameter value cannot be changed.
2	Lower or upper value limit exceeded.
3	Invalid subindex
11	No master control. FCT must accept device control in order to write this parameter. This error can only be generated via the service or network interface.
12	The password entered is wrong.
17	Request cannot be carried out due to operating status. Please check operating mode, stop and enable signals.
101	Request ID is not supported.
102	Parameter cannot be read (password).
103	The system of measurement has not been configured yet. Access to the parameter is not possible.
104	The cylinder type has not been configured yet. Access to the parameter is not possible.
105	The system of measurement units has already been configured and can no longer be changed without a data reset.
106	Cylinder type cannot be changed since it does not match the system of measurement units.
107	The value cannot be changed, since identification data are present. Please reset the identification data before writing the value.

Faults	Error description
108	The parameter value does not match the recognised hardware. (Note: The cylinder type must match the measuring system)
109	Serial numbers can only be changed after the identification data has been reset

Tab. 5.18 Error numbers for parameter transmission

5.4.2 Special features of the system of measurement units

The following special rules apply to accessing the system of measurement units. For detailed information on the system of measurement units ➔ Appendix B.1.

- The system of measurement units cannot be switched over at will. To change the system of measurement units, the axis data must be reset.
- After defining the system of measurement units (metric / imperial), the cylinder type must be transmitted. This defines the movement type translationally / rotationally.
- Only when the system of measurement units has been defined can PNUs be accessed that are larger than PNU 300 (exceptions: PNU 1100, 1190).

5.5 Cyclic parameterisation in the parameterisation mode

In the parameterisation mode, the FPC can be used to transmit one parameter at a time in the cyclic I/O data.
The PLC enters the order in the output data and waits until the CMAX has entered a response in the input data. This process takes several bus cycles.

FPC in the cyclic I/O data (➔ I/O allocation in Section 2.2.6)								
	Byte 1	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Output data	CCON	Subindex	Parameter identifier		Parameter value			
		Order byte 1 ... 7 of the FPC (➔ Section 5.4, Tab. 5.14)						
Input data	SCON	Subindex	Parameter identifier		Parameter value			
		Response byte 1 ... 7 of the FPC (➔ Section 5.4, Tab. 5.14)						

Tab. 5.19 FPC in the cyclic I/O data

Transmitted in the first byte is the control byte CCON, which controls the operating mode and release of the drive. The CMAX responds with the SCON status byte.
The CCON.STOP bit must not be set, since the CMAX cannot switch to “operation enabled” status in the “parameterisation” operating mode. CCON.STOP = 1 leads to a warning.
Some parameters can be written only in the “drive blocked” status (CCON.ENABLE = 0).

5.5.1 Example for parameterisation

Programmers can use the following example as an orientation for implementation.

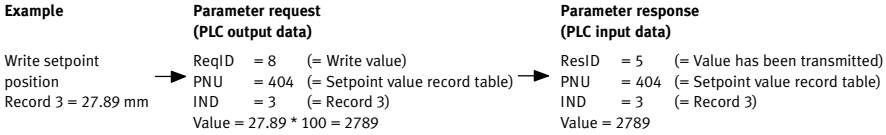

Example
Parameter request (PLC output data)
Parameter response (PLC input data)
Write setpoint position Record 3 = 27.89 mm
ReqID = 8 (= Write value)
PNU = 404 (= Setpoint value record table)
IND = 3 (= Record 3)
Value = 27.89 * 100 = 2789
ResID = 5 (= Value has been transmitted)
PNU = 404 (= Setpoint value record table)
IND = 3 (= Record 3)
Value = 2789

Fig. 5.3 Example of parameterisation

Preparing for parameterisation

Establish status for switching operating mode

Switching is permitted in the statuses “Controller blocked” or “Drive enabled” or “Error”.
Example “Drive enabled” status.

Allocation of the control bytes (prepare mode switch)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	**–**	**RESET**	**Brake**	**STOP**	**ENABLE**
	x	x	x	**0**	x	x	**0**	x
... Byte 2...8	Not relevant Recommendation: Set to 0							

CMAX feedback: Check ready for operation status in the status byte. SCON.READY must be 0.

Allocation of the status bytes (prepare change of operating mode)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT**	**24VL**	**FAULT**	**WARN**	**READY**	**ENABLED**
	x	x	0	x	x	x	**0**	x
... Byte 2...8	Not relevant							

Switch to parameterisation operating mode

Switching is permitted in the statuses “Controller blocked” or “Drive enabled” or “Error”.
Example “Drive enabled” status.

Allocation of the control bytes (switch to parameterisation operating mode)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	**–**	**RESET**	**Brake**	**STOP**	**ENABLE**
	1	**1**	x	**0**	x	x	**0**	x
... Byte 2...8	Set to 0							

CMAX feedback: parameterisation operating mode. SPOS.OPM1 and OPM2 must be 1.

Allocation of the status bytes (switch to parameterisation operating mode)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT**	**24VL**	**FAULT**	**WARN**	**READY**	**ENABLED**
	1	**1**	x	x	x	x	**0**	x
... Byte 0...8	**= 0**							

Carry out parameterisation

1st step: Prepare parameterisation with "No request"

Allocation of the control bytes (step 1)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	**–**	**RESET**	**BRAKE**	**STOP**	**ENABLE**
	1	**1**	x	0	x	x	**0**	x
Subindex Byte 2	Subindex of the parameter to be transmitted **=0**							
	0	0	0	0	0	0	0	0
Param. identifier Byte 3+4	PNU **= 0**							
	0	0	0	0	0	0	0	0
	ReqID **= 0**				PNU = n. r. (0000 0000 0000b)			
	0	**0**	**0**	**0**	0	0	0	0
Param. value Byte 5...8	Value of the parameter to be transmitted **= 0**							

Waiting for feedback from CMAX: "No request".

Allocation of the status bytes (step 1)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT**	**24VL**	**FAULT**	**WARN**	**Ready**	**ENABLED**
	1	**1**	x	x	x	x	**0**	x
Subindex Byte 2	Subindex of the parameter to be transmitted = not relevant							
	0	0	0	0	0	0	0	0
Param. identifier Byte 3+4	PNU = not relevant							
	0	0	0	0	0	0	0	0
	ResID = **0** (**0000**b)				PNU = 0			
	0	**0**	**0**	**0**	0	0	0	0
Param. value Byte 5...8	Value of the transmitted parameter: not relevant							

2nd step: Transmission of the parameter

Allocation of the control bytes (step 2)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
CCON Byte 1	**OPM2**	**OPM1**	**LOCK**	**–**	**RESET**	**BRAKE**	**STOP**	**ENABLE**
	1	**1**	x	**0**	x	x	**0**	x
Subindex Byte 2	Subindex of the parameter to be transmitted: **3** (0x03)							
	0	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Param. identifier Byte 3+4	PNU = **404** (0x0194 = 0001 **1001 0100**b)							
	1	**0**	**0**	**1**	**0**	**1**	**0**	**1**
	ReqID = **8** (0x08)				PNU = **404** (0x0194 = **0001** 1001 0100b)			
	1	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Param. value Byte 5...8	Value of the parameter to be transferred: **2789** (0x00000AE5, 32-bit number)							

Check feedback from the CMAX:

1. If ResID = 0: Parameter not yet processed.
   Wait.
2. If ResID = 7: Error handling (e.g. evaluate error number, check PNU or value)
3. If ResID = 5: End waiting.

Allocation of the status bytes (step 2)								
Bit	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**	**B1**	**B0**
SCON Byte 1	**OPM2**	**OPM1**	**FCT**	**24VL**	**FAULT**	**WARN**	**READY**	**ENABLED**
	1	**1**	x	x	x	x	**0**	x
Subindex Byte 2	Subindex of the transmitted parameter: **3** (0x0003 0000 0011b)							
	0	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Param. identifier Byte 3+4	PNU = **404** (0x0194 = 0001 **1001 0100**b)							
	1	**0**	**0**	**1**	**0**	**1**	**0**	**1**
	ResID = **5** (0x05 = 0101b)				PNU = **404** (0x0194 = **0001** 1001 0100b)			
	0	**1**	**0**	**1**	**0**	**0**	**0**	**1**
Param. value Byte 5...8	Value of the transferred parameter: **2789** (0x00000AE5, 32-bit number)							

3rd step: Complete parameterisation with “No request”

See step 1.

5.5.2 Flow diagram

Step 1
First send “No request” to ensure that the previous parameter request has been reliably terminated.

Step 2
Set the desired parameter request in the output data (request value, IND, PNU and ReqID).
The CMAX sends “No answer” for as long as it can provide the parameter response.
If the CMAX cannot process the request, this is indicated by ResID = 7. In this case, the response value contains the error number.

Step 3
Send “No request” after evaluation of the response.

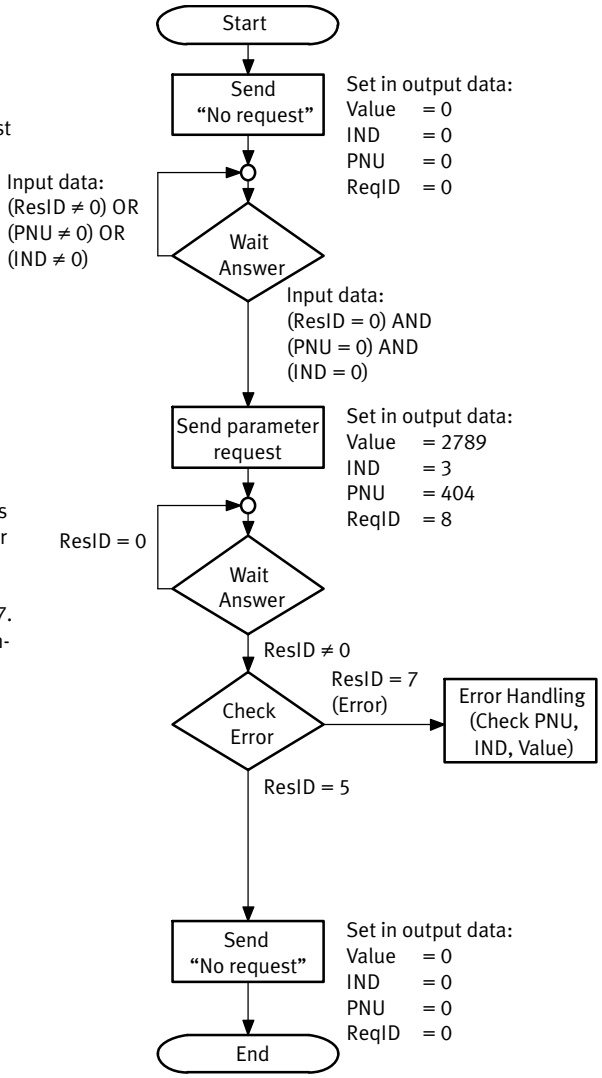


Fig. 5.4 Parameterisation flow chart

5.6 CPX module parameters

Per CPX module, 64 bytes are reserved for module parameters (function no.: 4828 + m*64 + 0...63) in the system table.

CPX module parameter of the CMAX		
Function no.	**Contents**	**Description**
4828 + m * 64 + 0	Module parameter 0	Reserved (standard module parameters, not used by the CMAX and not transmitted)
4828 + m * 64 + ...	Module parameters ...	
4828 + m * 64 + 5	Module parameter 5	
4828 + m * 64 + 6	Module configuration 1	Reserved (= 0 not used by the CMAX)
4828 + m * 64 + 7	Module configuration 2	
4828 + m * 64 + 8	Byte 8	Reserved
4828 + m * 64 + ...	Byte ...	
4828 + m * 64 + 63	Byte 63	

Tab. 5.20 CPX module parameter of the CMAX

The data format of the module is specified in CPX via the parameter “Data format analogue value” if used by the bus node (➔ Section 1.2).

A Notes on commissioning, service and firmware

A.1 Preparations and overview for commissioning

A.1.1 Checking the axis string

Prior to commissioning:

- Check the complete system structure, especially the tubing connection of the drive and the electrical installation ➔ CMAX system description.

A.1.2 Switching on the power supply, switch-on behaviour

Warning

High acceleration forces of the connected actuators. Uncontrolled movements can cause collisions which can lead to serious injury.

- **Switch on:**
  Always first switch on the operating voltage supply and then the compressed air supply.
- **Switch off:**
  Prior to mounting, installation and maintenance work, switch off the compressed air and power supply simultaneously or in the following sequence:
  1. compressed air supply
  2. operating voltage supply for electronics/sensors
  3. load voltage supply for outputs/valves

  Perform work in the machine area only with the compressed air and voltage supply switched-off and locked.

Delivery status (switching on for the first time or after data reset of the axis or device data)

– The connected components (valve, displacement encoder, sensor interface) are automatically searched for at the axis interface, and the information included is read.
– The recognized components are **not** automatically accepted as the setpoint configuration.
– Without complete parameterisation [1)] of the axis data, the controller cannot be activated. Actual values are not updated in that case.

Standard run up

– The connected components (valve and displacement encoder or sensor interface) are automatically searched for at the axis interface, and the information included is read.
– The actual configuration found is compared to the setpoint configuration. A deviations results in an error; the controller is not activated. This error can only be acknowledged after a parameterisation [1)].

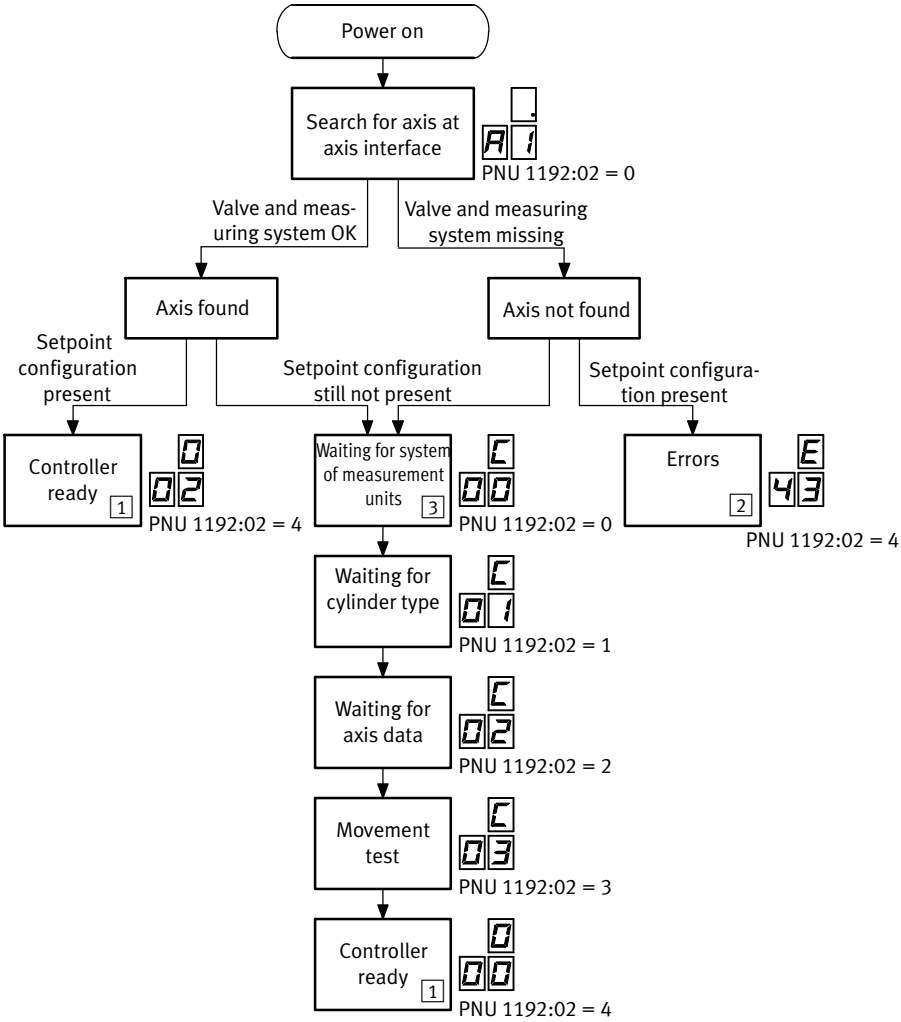
1) “Parameterisation executed”: Each parameter of the drive configuration area (for DNCI also homing) includes data that makes sense.

Recognisable parameters
The CMAX automatically ascertains all the parameter values stored in the drive, valve, displacement encoder or sensor interface. The FCT plug-in can read these values from the CMAX; they do not have to be entered in the FCT project. The ascertained data cannot be overwritten.

Resetting the axis data
An axis data reset (➔ Appendix A.3.4) puts the axis data of the CMAX into the delivery status. In this status, the CMAX contains no setpoint configuration. Parameterisation is required to activate the controller.

Configuration without hardware
The CMAX can also be configured without connected components. And so a CMAX can be installed in a machine pre-parameterised as a spare part and placed in operation without a PC/FCT.
If configuration is performed without components, all the data needs to be entered. After valve and displacement encoder or sensor interface have been connected, the CMAX performs automatic hardware recognition when switched on. If the setpoint configuration agrees with the actual configuration, the user can perform the movement test. The serial numbers of the components are automatically taken over into the setpoint configuration.
Note: After configuration, the CMAX reports error E43 until a new hardware has been connected.

Configuration mode
To indicate the status of configuration, the display shows the status C00 ... C03
(can also be checked by reading out the PNU 1192:02). These statuses each label
the next required action.



1 Initial start-up executed; CMAX ready for operation

2 Error ➔ Chapter 4

3 Status when switching on for the first time (in delivery status or after data reset): Wait for initial start-up

Fig. A.1 Switch-on behaviour

Description of statuses

PNU 1192:02 = 0

Valve and displacement encoder are searched for.
This process takes max. 3 seconds.

PNU 1192:02 = 0

The CMAX has not found a setpoint configuration. The system of measurement units has not yet been defined.
The user must first define the system of measurement units. As long as no system of measurement units has been configured, access to the axis parameters is restricted, since the CMAX does not know in what way the parameters need to be scaled. You only have access to diagnostic data and to data required to define the system of measurement units.
The system of measurement units is defined with PNU 1192:05.

The following data can be accessed in this status:

PNU:IND	Access	Description
1xx 2xx	Read/write	Device data: define device names, version numbers Diagnostic data: read current message
1190:01 1190:05 1190:11	Read	From hardware recognition: Cylinder type, measurement system type, valve type
1192:03	Read/write	Carry out data reset
1192:05 1192:06	Read/write Read	System of measurement units System of measurement units table

Tab. A.1 Access to parameters in status C00

PNU 1192:02 = 1

The system of measurement units has been defined. The CMAX waits for the cylinder type to be defined.
It is now defined whether the metric or imperial system of units is used. However, the parameters can still not be scaled, because a distinction between translatory (linear drive) and rotatory (semi-rotary drive) needs to be made. To do this, the cylinder type (PNU 1100) must be written. The cylinder type defines the system of measurement units table actually used (➔ PNU 1192:06).

PNU 1192:02 = 2

The system of measurement units and the cylinder type have been successfully established. The CMAX waits for the axis parameter to be written.
The recognized hardware has been scaled. Appropriate specification data has been created in the system of measurement units. There is access to all parameters, so now the recognized cylinder length, measuring system length, etc., can be read.
Now the axis configuration needs to be transmitted (download).

PNU 1192:02 = 3

Basic parameterisation has been completed. The axis can now be used.
A movement test can be performed. During this test, the drive is checked for correct tubing connection.
The movement test can be skipped by writing the PNU 1192:07 = 2 (not recommended).

Commissioning errors

Fig. A.1 only shows the most important paths in order to explain the principle.
If only one component is found (that is, displacement encoder, sensor interface or valve), error E60 or E80 is generated, since it can be assumed that this is a defect. Apart from that, there are also other possible errors prior to or during commissioning, e.g.

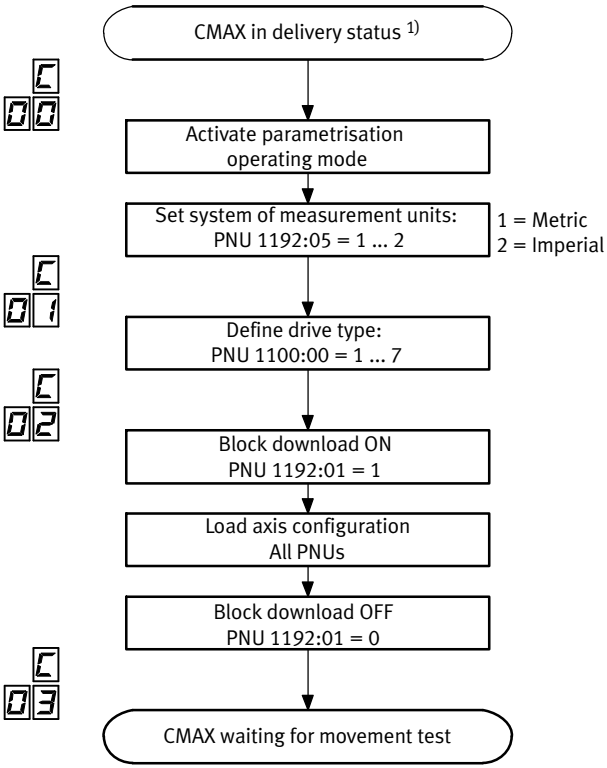
– insufficient operating voltage E52,
– memory error E7x,
– drive enabled before reaching status C03 (causes E05).

More information on the status display ➔ CMAX system description.

A.2 Commissioning through the higher-order controller

A.2.1 C00: Basic parameterisation

This section includes step-for-step instructions for basic parameterisation. Fig. A.2 shows an overview for the approach. The description of the statuses C00 to C03 is required for understanding (➔ Appendix A.1.2, Fig. A.1).


CMAX in delivery status 1)
C00
Activate parametrisation operating mode
Set system of measurement units: PNU 1192:05 = 1 ... 2
1 = Metric
2 = Imperial
C01
Define drive type: PNU 1100:00 = 1 ... 7
C02
Block download ON PNU 1192:01 = 1
Load axis configuration All PNUs
Block download OFF PNU 1192:01 = 0
C03
CMAX waiting for movement test

1) A data reset sets the axis data back to the delivery status, while the device and diagnostic data are retained.

Fig. A.2 Basic parameterisation

Commissioning operations (PNU 1192)

The “Commissioning operations” parameter controls important functions of commissioning. Writing the parameter triggers complex actions in the controller, which are essential for commissioning.

➔ Section C.2.16.

The function “data reset” (PNU 1192:03) offers the possibility to reset the axis configuration at any time. Resetting deletes the axis data and the identification data. So you will always need to repeat commissioning and identification after a reset.

A.2.2 Step-by-step instructions for basic parameterisation

Switch on CMAX. Status C00 becomes active.

1. Check status (read PNU 1192:02 › setpoint = 0).
2. Recommendation: Write device names (PNU 121).
   In principle, the default value “CMAX1” can be used, but an individual name is recommended in case you intend to access the CMAX with FCT as well.
3. Check version number of the firmware (read PNU 101).
   Prior to parameterisation, you should ensure that the CMAX is really compatible with the following project data.

Select parameterisation operating mode

4. Activate parameterisation operating mode in the CCON; wait for acknowledgement in the SCON.
   CCON.STOP and CCON.ENABLE must not be set.

	B7	B6	B5	B4	B3	B2	B1	B0
CCON	**OPM2**	**OPM1**	**LOCK**	**–**	**RESET**	**Brake**	**STOP**	**ENABLE**
Target	1	1	x	0	x	x	0	0
SCON	**OPM2**	**OPM1**	**FCT**	**24VL**	**FAULT**	**WARN**	**READY**	**ENABLED**
Target	1	1	0	x	0	0	0	0

Define system of measurement units

5. Define the desired system of measurement units (PNU 1192:05).
   1192:05 = 1 -› metric / SI system
   (metre, kilogramme, Newton, ...)
   1192:05 = 2 -› imperial system
   (inch, pound, pound-force, ...)
   Writing the parameter results in setting the commissioning status C01.
   This can be checked by reading the PNU 1192:02.

Write cylinder type

6. Write cylinder to the setpoint configuration (PNU 1100:01). The cylinder type must match the value from the automatic hardware recognition. The recognised value can be read from the actual configuration (PNU1190:01).
   The cylinder type defines the system of measurement units used. The CMAX now scales the length specifications from the actual configuration into the established system of measurement units. Now all the parameters can be accessed.
7. Writing the parameter sets the commissioning status C02. This can be checked by reading the PNU 1192:02.

Switch on block download

8. Switch on block download (write PNU 1192:01 = 1).
   During block download, the controller is not recalculated. The parameters are only checked for limit values during writing. Dependencies between parameters are not checked. This function permits loading parameters in any order.
   Example for dependent parameters: The software end positions depend on the cylinder length.

Load axis data

9. Each parameter from the drive configuration group (also homing with the DNCI) must be appropriately initialised. All written parameters must match the recognised parameters.
   The following data must be written:

Setpoint configuration	Actual configuration	Parameter
PNU 1100	PNU 1190:01	Cylinders
PNU 1101	PNU 1190:03	Cylinder diameter
PNU 1102	PNU 1190:05	Cylinder length (nominal length)
PNU 1103	PNU 1190:04	Piston rod diameter
PNU 1110	PNU 1190:10	Displacement encoder
PNU 1111	PNU 1190:11	Displacement encoder length
PNU 1120	PNU 1190:20	Valve

The following parameters should be written:

Application data	Specification	Parameter
PNU 1140	0°	Installation position
PNU 1141	6 bar	Supply pressure
PNU 1142	5 kg	Base load

With the DNCI / DDPC, the following should also be written:

Axis data	Parameter
PNU 1130	Offset axis zero point
PNU 1131	Homing speed
PNU 1132	Homing method

For DGCI, the following must be written:

Axis data	Specification	Parameter
PNU 1104.01	0 (not present)	DGCI options: integrated clamping unit
PNU 1104.02	0 (not present)	DGCI options: additional slide
PNU 1104.03	0 (not present)	DGCI options: lubrication function
PNU 1104.04	0 (not present)	DGCI options: protected recirculating ball bearing guide
PNU 1104.05	0 mm	DGCI options: distance between slide and additional slide KR
PNU 1104.06	0 mm	DGCI options: distance between slide and additional slide KL

All the other parameters contain appropriate default values. This data can, but does not need to be overwritten. The record table is not initialised.

Switch off block download

10. Switch off block download (write PNU 1192:01 = 0).
    When switching off block download, the controller is parameterised for the first time. If all the required parameters were written during axis data writing, status C02 is exited. From this time on, for the first time, the actual position can be read or any other function of the CMAX can be executed.
    The CMAX now waits for the movement test to be executed.

A.2.3 Parameterisation without hardware

Features

- The CMAX can be fully parameterised without hardware ➔ A.1.1. Connecting an axis is not required for this purpose.
- If no axis is connected, the CMAX indicates an error after parameterisation. The CMAX is still fully diagnostics-capable and parameterisable.
- Without hardware all parameterised data can be read. Connecting an axis is not required.

Cylinder length

The actual cylinder length (cylinder pipe length) is stored for the DGCI. The CMAX accepts both effective and nominal lengths for nominal/actual comparison.
The CMAX accepts a deviation of 5.00 mm between the projected length and the length stored in the drive without issuing an error or warning.

A.2.4 C03: Movement test

After parameterisation, a movement test should be executed to check the drive's control direction. During this, the system checks that the tubes are correctly connected. After parameterisation, the CMAX expects the movement test to be executed and indicates this by showing C03 on the display. The movement test must either be executed or skipped (not recommended).

Information on performance of the movement test ➔ Section 3.2.1.

A.2.5 Homing and identification

After the successful movement test, the following functions need to be executed:

- Homing (only for incremental displacement encoder) ➔ Section 3.2.2
- Identification ➔ Section 3.2.3

A.3 Operation and service

A.3.1 Target/actual comparison

The CMAX, together with valve, cylinder and displacement encoder, forms a variable modular system. The controller is dependent on the design and size of the components as well as their individual characteristics, which are determined in the identification. To avoid errors in operation with the CMAX, the CMAX carries out automatic detection of the connected hardware and a comparison of target and actual configuration.

The CMAX distinguishes 3 different configurations

Nominal configuration

The nominal configuration consists of the values for the drive configuration parametrised by the user.

Actual configuration (PNU 1190)

The actual configuration consists of the values for the hardware components ascertained during the automatic hardware recognition.

Start configuration (PNU 1195)

The start configuration includes important configuration data at the time of the last identification. After the identification, the current nominal configuration may only be modified within certain limits, which are defined by the start configuration.

A comparison of the nominal and actual configuration takes place in the following situations:
- after switch-on
- after adjustment of specific parameters, in particular of configuration
- after restart of the axis with error acknowledgment

Why is the comparison carried out?

1. The comparison should ensure that the correct axis is connected. Up to 8 CMAX can be operated in a CPX terminal. The connected axes must be uniquely assigned to the respective CMAX.
2. The controller must know the design and size of the drive in order to be able to work correctly. Defective specifications, defective statements, e.g. of the diameter, would result in an unstable regulation.
3. To determine specific system characteristic values of the axes, identification must be carried out for each axis during commissioning. If components are exchanged, the identification should be repeated.

The CMAX checks in a target-actual comparison whether the target configuration agrees with the actual configuration (⟶ error E01) and whether components were replaced (⟶ warning W08 or error E01)

Comparison of design and size

The design and size of the drive must be checked. They must agree within the tolerance so that the controller can be correctly parameterised.

Parameter	PNU of the reference configuration	PNU of the actual configuration	Tolerance
Cylinder	1100	1190.1	–
Cylinder length[1)]	1101	1190.2 or 1195.5	5 mm
Cylinder diameter	1102	1190.3	–
Displacement encoder	1110	1190.10	–
Displacement encoder length	1111	1190.11	5 mm
Valve	1120	1190.20	–

1) Only for DGCI/DDLI: comparison with cylinder nominal length (PNU 1195.5) and cylinder pipe length (1195.2). The setpoint value must agree with one of the two values.

Tab. A.2 Parameter setpoint/actual configuration and tolerances

In case of impermissible deviation, error E01 is generated. In this case, the setpoint configuration must be adapted to the actual configuration so that work can continue. The setpoint configuration can only be changed after the current identification data have been deleted. The CMAX does not take over the configuration automatically and also does not delete the identification data automatically.
After the setpoint configuration has been adapted, the movement test and the identification must be carried out again.

Important

The CMAX checks only the parameters that are read out of the components during automatic hardware detection. If, for example, a DNCI cylinder is replaced, the CMAX cannot detect it. In this case, the movement test and identification must still be performed by the user.

Comparison of serial numbers

If the valve, cylinder or sensor interface have been replaced by a component of the same design and size, this is determined by a change of serial numbers. If a component has been replaced, a movement test must be executed and it should be newly identified. If the movement test is performed by the user, the new serial number is taken over into the setpoint configuration.

Serial number parameter	PNU of the reference configuration	PNU of the actual configuration	Error	Execute movement test
Cylinder DGCI or DDLI[1)]	1122	1190.12	W08	Yes
Sensor interface	1122	1190.12	–	No[2)]
Valve	1122	1190.21	W08	Yes
Measuring system and valve	See above.	See above.	E01	Yes

1) More precisely: serial number of the integrated displacement encoder, distinction from sensor interface through evaluation of the design

2) Differences are ignored, because replacement does not influence the tubing connection (movement test not necessary)

Tab. A.3 Serial numbers nominal/actual configuration

If the user has replaced both the valve and the cylinder / sensor interface, the axis string may have been interchanged if several CMAX have been used. And so in this case E01 would also be generated. In case of an interchange, to permit further work as quickly as possible and without use of the FCT, the CMAX permits work at first without a new identification. But the warning W08 remains, since the system characteristic values of the new components have not yet been determined. The serial number of the start configuration is updated and the warning W08 is acknowledged only when a new identification has also been made.

Serial number parameter	PNU of the start configuration	PNU of the actual configuration	Error	Carry out identification
Cylinder DGCI or DDLI[1)]	1195.6	1190.12	W08	Recommended
Sensor interface	1195.6	1190.12	–	No[2)]
Valve	1195.7	1190.21	W08	Recommended
Measuring system and valve	See above.	See above.	E01	Yes

1) More precisely: serial number of the integrated displacement encoder, distinction from sensor interface through evaluation of the design

2) Differences are ignored, because replacement does not influence drive parameters, such as friction (identification not necessary)

Tab. A.4 Serial numbers start/actual configuration

A.3.2 Commissioning via the controller after replacement of components

Example: In a commissioned CMAX system, the defective proportional valve VPWP-6 is replaced with a new proportional valve VPWP-6. FCT should not be used, and so the the movement test and the identification are carried out via the controller.

Replace valve

1. Switch off 24 V power supply and compressed air.
2. Replace VPWP-6 and completely connect it electrically and pneumatically.
3. Switch on 24 V power supply and compressed air correspondingly ➔ A.1.2.

In the CMAX display, “C03” is shown and the warning “W8 – cylinder, valve, displacement encoder or sensor interface were replaced” is output.

Execute movement test:

1. Activate commissioning operating mode:
   CCON.OPM2 (bit 7) = 1; set all other signals to 0
2. Set byte 3 (function) = 2.
3. Enable operation (CCON.STOP = 1) and drive (CCON.ENABLE = 1).
4. The movement test is started with start (CPOS.START = 1).
   In the CMAX display, “8” (movement test active) and the progress in % are displayed.
5. The successful movement test is reported through Motion Complete (SPOS B2 MC = 1) and “400” in the CMAX display.

Carry out identification (recommended):

Commissioning operating mode is still active.

1. Set byte 3 (function) = 1.
2. Identification is started with start (CPOS.START = 1).
   In the CMAX display, “7” (identification active) and the progress in % are displayed.
3. Successful identification is reported through Motion Complete (SPOS.MC = 1) and “400” in the CMAX display.

End commissioning

To switch to the operating mode for production (record mode/direct mode):

1. Activate stop (CCON.STOP = 0).
2. Change the operating mode, e.g. CCON.OPM1 = 0 and CCON.OPM2 = 0 (record mode).
3. Enable operation again with CCON.STOP = 1. The CMAX controller is ready again for the production operating mode.

A.3.3 Change reference configuration

The controller of the CMAX must recognize the design and size as well as some system parameters (e.g. operating pressure) in order to function correctly. If there is a change in the drive or system, the user should likewise adjust the corresponding parameters in the CMAX.
Some of these parameters influence identification (➔ Section 3.2.3) in such a way that, when they are adapted, identification must be carried out again. After identification has been carried out, these parameters can only be adjusted within the specified tolerances. For larger changes, the identification data must first be deleted or an axis data reset carried out.

Important: If a check against the reference configuration does not make sense, the start configuration (PNU 1195) includes the values that were used in the last identification.

Parameter	New value for PNU	Comparison with	Tolerance
Cylinder			
Design	1100	Current value	–
Length	1101	1195.1	5 mm
Diameter	1102	Current value	–
Piston rod diameter	1103	Current value	–
Integrated clamping unit (only DGCI)	1104.1	Current value	–
Displacement encoder			
Design	1110	Current value	–
Length	1111	1195.2	5 mm
Serial number	1112	1195.6	–
Valve			
Design	1120	Current value	–
Serial number	1121	1195.7	–
Application parameter			
Mounting position	1140	1195.4	3°
Operating pressure	1141	1195.5	1 bar
Dual axis	1143.2	Current value	–
Through piston rod	1143.4	Current value	–

Tab. A.5

Urgent recommendation
After changes to the system (e.g. the operating pressure), the parameters of the CMAX should be adjusted and a new identification carried out.

A.3.4 Data reset

A data reset is used to reset some or all parameters of the CMAX to the factory settings. That always makes sense if parts of the drive or system have changed and the configuration must be adjusted. Various resets make sense, depending on the extent of the change ➔ Tab. A.6:

Reset	Description
Identification data	An identification data reset makes sense if only some changes have to be performed, but which require deletion of the identification data (➔ 3.2.3). After the configuration is adapted, identification must be performed again. – The identification data and the adaptation data are reset. – All the other data is retained. The data reset is triggered by writing the commissioning parameter “Data reset” PNU 1192:03 = 2.
Axis data	An axis data reset always makes sense if large parts of the reference configuration have to be reset, e.g. because the CMAX must be used together with another axis. It also makes sense to perform a data reset before commissioning through a higher-order controller in order to obtain a defined initial status. – The measuring system is reset. – All application parameters (drive configuration, record table, project data, etc.) of an axis are reset to the delivery status. – The identification data, adaptation data and maintenance data of an axis are reset. – The diagnostic memory is retained and contains the entry “data reset”. – Device data such as device name, operating time are retained. – A password is not deleted. – The CMAX changes into the configuration mode C00 The data reset is triggered by writing the commissioning parameter “Data reset” PNU 1192:3 = 3.
Device data	The CMAX is completely reset to the delivery status – All parameters are deleted as with axis data reset. – In addition, a password specified in the device and the diagnostic memory are deleted This function is only available at the diagnostic interface and can only be triggered by FCT. After the reset it is no longer possible to communicate with the CMAX. The display shows 3 flashing dashes “---”. The CPX terminal must be switched off and then back on again. **Note**: The FCT plug-in V2.2 and higher automatically performs a restart of the CPX terminal.
Movement test	The movement test must be reset before it can be carried out again. This reset is required if a component has been replaced without the CMAX detecting it based through the serial numbers (example: cylinder DNCI has been replaced). The movement test is reset by writing PNU 1192:07 = 1.

Tab. A.6 Types of data reset

When a data reset is mentioned in general, it refers to an axis data reset.

A.3.5 Firmware update

Updating the CMAX firmware can be performed through the FCT plug-in CMAX via the service or network interface of the bus node.
If no valid firmware is loaded on the module at the time of switching on, the error E74 “no firmware” is indicated.
Bring the system into a safe status before the firmware download. Reset to 0 all controller-output data for the CMAX, i.e. byte 1 ... 8. The controller must not block access for the FCT.
Recommendation: The controller should be switched into the stop status. If possible, physically disconnect the bus connection to the CPX terminal, i.e. pull out the bus cable at the CPX terminal.
Procedure for firmware update ➔ Section A.8.

A.3.6 Switch-on behaviour and power-down

If a failure of the operating voltage is detected, all user data (device and axis parameters, identification and adaptation data) are saved retentively. After switch-on, a check is made whether the data backup of the CMAX was performed without errors the last time the system was switched off. In the event of an error, E76 (power-down error) is issued.
If the CMAX reports E76, the last successfully saved data are present in the controller. Parameters, such as record list, axis configuration, etc. can meanwhile have been changed by the user. These changes are then lost. Adaptation data and identification data are possibly invalid and must not be used. Therefore, error E76 cannot be acknowledged. The user must execute an axis data reset and commission the axis again. The data stored in the CMAX can be read beforehand with the plug-in.

A.3.7 Optimisation of the response delay for error E50

The print monitoring can be parameterised with the parameter “response delay E50” (PNU 1144). Parameterisation also applies if E50 has been parameterised as W50. The response monitoring E50 defines two monitoring times for the supply pressure: the time for the first pressure rise of 100 mbar and the maximum time until the minimum pressure is reached.

For monitoring of the supply pressure, the CMAX uses the pressure sensors of the VPWP. These measure the pressures in ports 2 and 4 of the valve. From these pressures, it can be determined in normal operation whether the supply pressure (port 1) is present.

After a long rest period or after the cylinder is vented through an additional circuit, the following effect can occur:

– After switch-on, the VPWP is at first in the middle position, that is, the valve is blocked.
– The pressure in the ports 2 and 4 is at first built up only through leakage of the valve and, as a result, only slowly.

To ensure in this case that no error E50 is reported when CCON.ENABLE is set, after enable, the CMAX first monitors the pressure rise and reaching of the minimum pressure.

The behaviour at enable is thus as follows:

1. Before CCON.ENABLE is set, neither error nor warning is reported. An existing message can be acknowledged.
2. If CCON.ENABLE=1 is set and the chamber pressures are too small, a pressure rise of 100 mbar (1.5 psi) must be detected within the pressure rise time. If a sufficiently large pressure rise is not present, an error or warning is reported.
3. If a pressure rise is detected, the controller is enabled and SCON.ENABLED is set, even if the defined minimum pressure is not yet present. After that, the minimum pressure must have been reached in at least one cylinder chamber within the maximum time. No E50 is reported until this time has passed.

If no error is reported, a positioning command can be started right after step 2. At a start, if no sufficient supply pressure is present within this monitoring time, error E30/E31 can result.

Standard parameterisation is sufficient in most cases to avoid “false” E50 messages. For very large drives, an adjustment can make sense. The parameter can be adjusted in the FCT on the page “I/O data ...”.

A.4 Programming flow charts

The following sections include flow charts for CMAX control via I/O for typical applications.

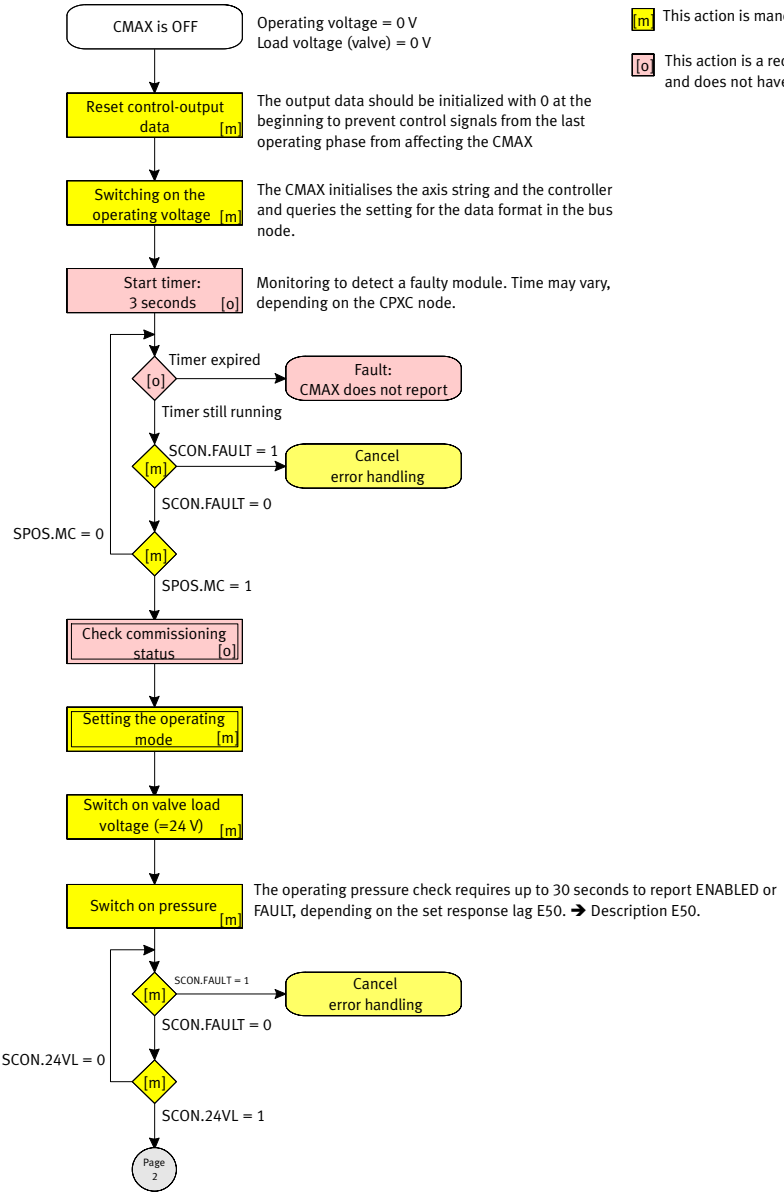
A.4.1 Establishing the ready status

Requirements

– Valve operating voltage and load voltage OFF.
– Fieldbus master is ready for communication, so communication is established as soon as the CPX terminal is switched on. If this is not the case, additional time must be allowed for change of the byte order after establishment of communication.

Notes

– All enabling bits (CCON.ENABLE, CCON.STOP, CCON.BRAKE) can be set right from the beginning and simultaneously. Correspondingly, feedback can be evaluated simultaneously.
– When exchanging components, the movement test is reset automatically, if applicable. The movement test status should therefore be checked before switching on and, if necessary, the test should be re-run automatically or guided by the user.
– Setting the operating mode should be done in a separate module of the control at a central position (➔ Appendix A.4.4).
– If the CMAX reports a fault, not all of the expected status signals can be reported, depending on this fault. Evaluation of SCON.ENABLED or SCON.OPEN, for example, should then be aborted.


[m] This action is mandatory.
[o] This action is a recommendation and does not have to be performed
CMAX is OFF
Operating voltage = 0 V
Load voltage (valve) = 0 V
Reset control-output data [m]
The output data should be initialized with 0 at the beginning to prevent control signals from the last operating phase from affecting the CMAX
Switching on the operating voltage [m]
The CMAX initialises the axis string and the controller and queries the setting for the data format in the bus node.
Start timer: 3 seconds [o]
Monitoring to detect a faulty module. Time may vary, depending on the CPXC node.
[o]
Timer expired
Fault: CMAX does not report
Timer still running
[m]
SCON.FAULT = 1
Cancel error handling
SCON.FAULT = 0
SPOS.MC = 0
[m]
SPOS.MC = 1
Check commissioning status [o]
Setting the operating mode [m]
Switch on valve load voltage (=24 V) [m]
Switch on pressure [m]
The operating pressure check requires up to 30 seconds to report ENABLED or FAULT, depending on the set response lag E50. ➔ Description E50.
[m]
SCON.FAULT = 1
Cancel error handling
SCON.FAULT = 0
SCON.24VL = 0
[m]
SCON.24VL = 1
Page 2

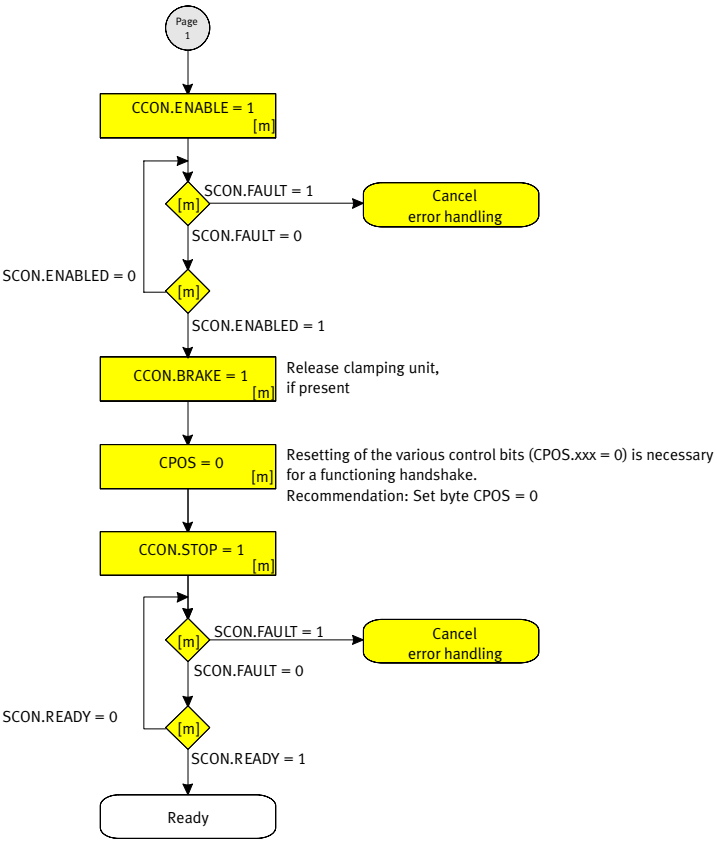


Fig. A.3 Flow diagram for create readiness to operate

A.4.2 Start record

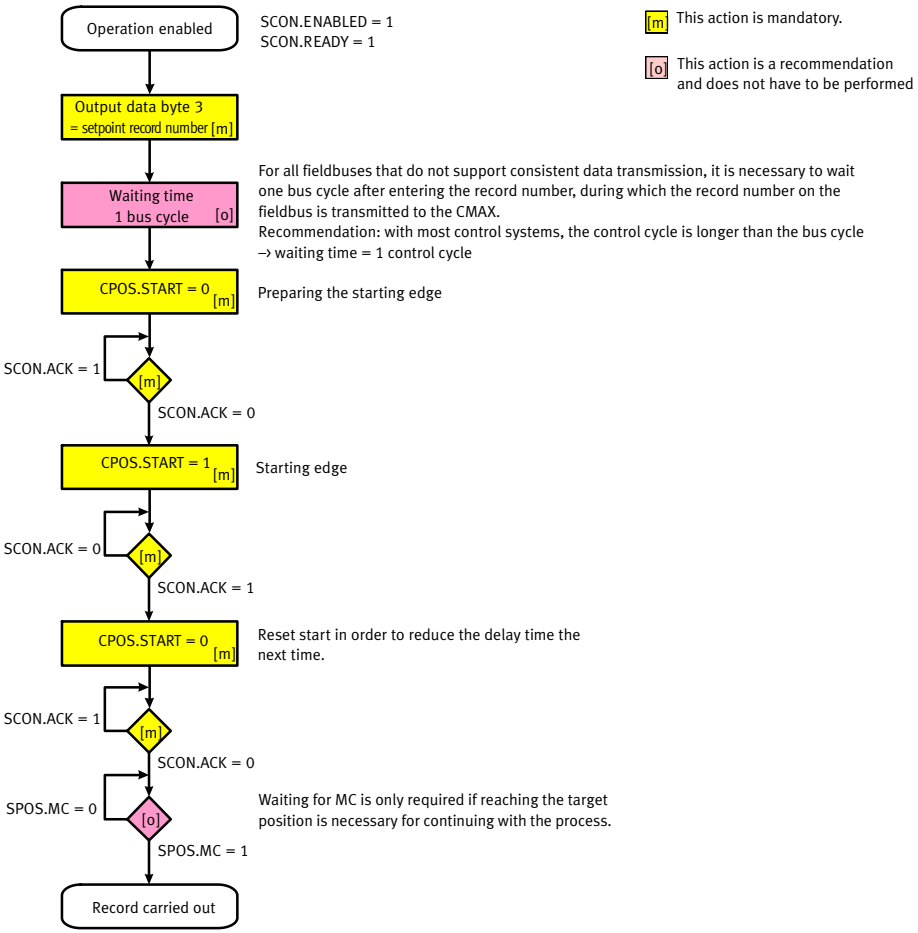

Operation enabled
SCON.ENABLED = 1
SCON.READY = 1
[m] This action is mandatory.
[o] This action is a recommendation and does not have to be performed
Output data byte 3
= setpoint record number [m]
Waiting time
1 bus cycle [o]
For all fieldbuses that do not support consistent data transmission, it is necessary to wait one bus cycle after entering the record number, during which the record number on the fieldbus is transmitted to the CMAX.
Recommendation: with most control systems, the control cycle is longer than the bus cycle –› waiting time = 1 control cycle
CPOS.START = 0 [m]
Preparing the starting edge
SCON.ACK = 1
[m]
SCON.ACK = 0
CPOS.START = 1 [m]
Starting edge
SCON.ACK = 0
[m]
SCON.ACK = 1
CPOS.START = 0 [m]
Reset start in order to reduce the delay time the next time.
SCON.ACK = 1
[m]
SCON.ACK = 0
SPOS.MC = 0
[o]
Waiting for MC is only required if reaching the target position is necessary for continuing with the process.
SPOS.MC = 1
Record carried out

Fig. A.4 Sequence diagram for start record

A.4.3 Acknowledge error

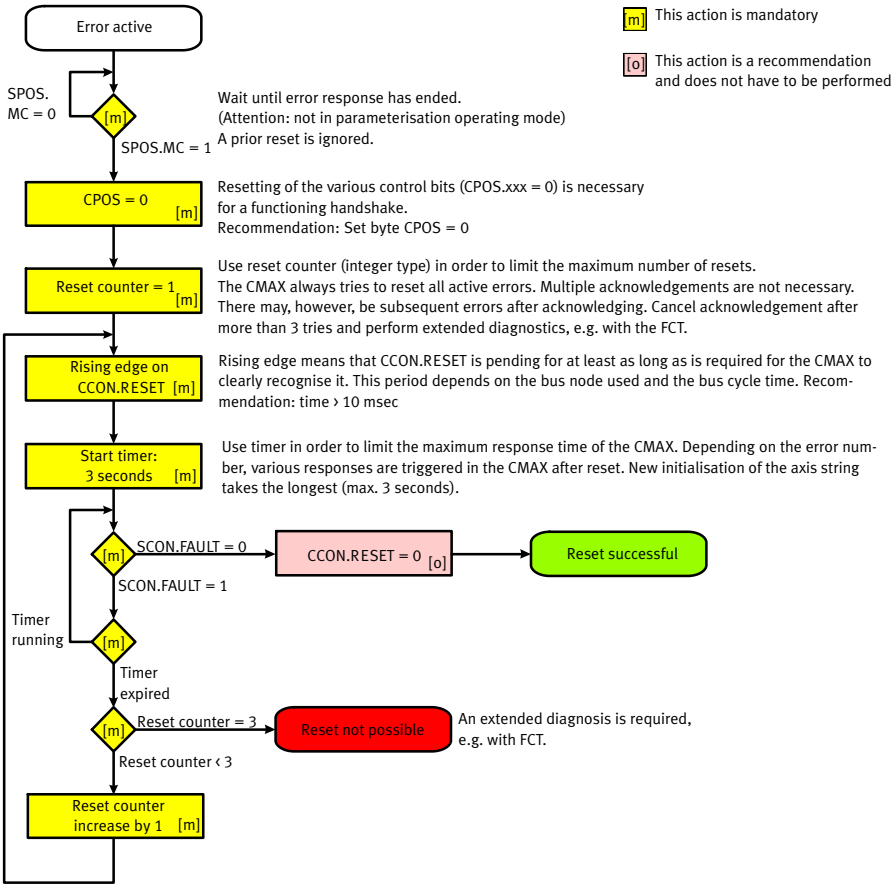

[m] This action is mandatory
[o] This action is a recommendation and does not have to be performed
Error active
SPOS. MC = 0
[m]
Wait until error response has ended. (Attention: not in parameterisation operating mode) A prior reset is ignored.
SPOS.MC = 1
CPOS = 0 [m]
Resetting of the various control bits (CPOS.xxx = 0) is necessary for a functioning handshake. Recommendation: Set byte CPOS = 0
Reset counter = 1 [m]
Use reset counter (integer type) in order to limit the maximum number of resets. The CMAX always tries to reset all active errors. Multiple acknowledgements are not necessary. There may, however, be subsequent errors after acknowledging. Cancel acknowledgement after more than 3 tries and perform extended diagnostics, e.g. with the FCT.
Rising edge on CCON.RESET [m]
Rising edge means that CCON.RESET is pending for at least as long as is required for the CMAX to clearly recognise it. This period depends on the bus node used and the bus cycle time. Recommendation: time › 10 msec
Start timer: 3 seconds [m]
Use timer in order to limit the maximum response time of the CMAX. Depending on the error number, various responses are triggered in the CMAX after reset. New initialisation of the axis string takes the longest (max. 3 seconds).
[m]
SCON.FAULT = 0
CCON.RESET = 0 [o]
Reset successful
SCON.FAULT = 1
Timer running
[m]
Timer expired
[m]
Reset counter = 3
Reset not possible
An extended diagnosis is required, e.g. with FCT.
Reset counter ‹ 3
Reset counter increase by 1 [m]

Fig. A.5 Acknowledge error flow diagram

A.4.4 Switch over operating mode

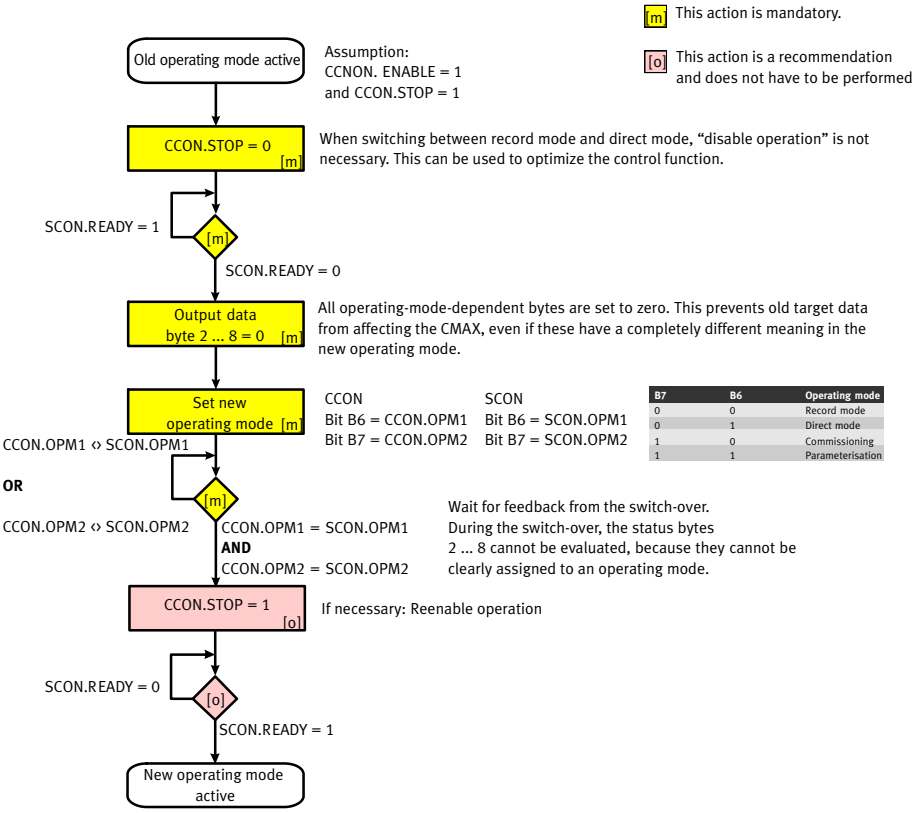

[m] This action is mandatory.
[o] This action is a recommendation and does not have to be performed
Old operating mode active
Assumption:
CCNON. ENABLE = 1
and CCON.STOP = 1
CCON.STOP = 0 [m]
When switching between record mode and direct mode, “disable operation” is not necessary. This can be used to optimize the control function.
SCON.READY = 1
[m]
SCON.READY = 0
Output data byte 2 ... 8 = 0 [m]
All operating-mode-dependent bytes are set to zero. This prevents old target data from affecting the CMAX, even if these have a completely different meaning in the new operating mode.
Set new operating mode [m]
CCON
Bit B6 = CCON.OPM1
Bit B7 = CCON.OPM2
SCON
Bit B6 = SCON.OPM1
Bit B7 = SCON.OPM2
B7 B6 Operating mode
0 0 Record mode
0 1 Direct mode
1 0 Commissioning
1 1 Parameterisation
CCON.OPM1 ‹› SCON.OPM1
OR
[m]
CCON.OPM2 ‹› SCON.OPM2
CCON.OPM1 = SCON.OPM1
AND
CCON.OPM2 = SCON.OPM2
Wait for feedback from the switch-over.
During the switch-over, the status bytes
2 ... 8 cannot be evaluated, because they cannot be clearly assigned to an operating mode.
CCON.STOP = 1 [o]
If necessary: Reenable operation
SCON.READY = 0
[o]
SCON.READY = 1
New operating mode active

Fig. A.6 Flow diagram for Switch over operating mode

A.5 Firmware designs

A.5.1 Firmware Design 2.2

Firmware design 2.2 requires at least the plug-in version 2.2.

The following list shows the most important new and improved characteristics of the firmware Version 2.2, including the plug-in 2.2.

I/O data

- The actual position and actual force can simultaneously be transferred into the input data of the controller. This makes it possible to create force-path diagrams or implement force-path monitoring functions in the controller in real time. This is parameterised in the FCT plug-in on the “Diagnostics/ I/O Data” page in the “I/O Data” tab.
- For fast and easy diagnostics, the error number can be transferred in the input data (as secondary actual value in byte 4). As a result, an additional parameter application in case of error is no longer necessary. This function is parameterised in the FCT plug-in on the “Diagnostics/ I/O Data” page in the “I/O Data” tab.
- If the CCON.LOCK control bit is set by the controller, the FCT plug-in has only read access on the CMAX. Previously, certain optimisation functions (e.g. adapt controller parameters) could still be performed. As a result, safety concepts of the system operator implemented on the controller are supported.
- The status bits RSB.RCE are now set with E27 as well.
- The designations of some I/O bits have been improved.

Plug-in 1.8 or earlier	Plug-in 2.2
SCON.OPEN	SCON.READY
SCON.FCT_MMI	SCON.FCT
CDIR.ABS	CDIR.REL
SDIR.ABS	SDIR.REL
RCB1.ABS	RCB1.REL

Tab. A.7 New improved designation of control and status bits

Monitoring of the supply pressure (error E50)

The error number E50 (supply pressure too low) is parameterised in the factory as a warning in V2.2 or higher. With this setting, too little pressure in the cylinder chambers does not result in an interruption of the process and a change to the error status. A positioning task can be started, despite the warning message.

This is especially advantageous for large-scale cylinders, since a longer waiting time after the operating pressure is switched on is not required. If for some reason no operating pressure is present, the malfunction numbers E30, E31 or E56 report, after the start of a positioning task, that the expected movement did not take place and signal that the drive is in a defective status.

If too little supply pressure should continue to be reported as an error, E50 must be parameterised correspondingly in the plug-in on the “Diagnostics/ I/O Data” page in the “Reaction to Messages” tab.

Additionally, the response delay of the E50 message has been improved. The response delay can be adapted if required. Plug-in “Diagnostics/ I/O-data” page “Configure Messages” tab. Details ➔ A.3.7.

Force control
Optimisation and increase in the robustness of the force controller against interference from the application. These include:
– Avoidance of unexpected backward movements of the drive related to the direction of force.
– Avoidance of unintended movements in the case of fast interference forces while force control is being applied.
– Improvement of the switch to force control when the axis is not yet at rest after a positioning command.

Support of DGCI characteristics
The DGCI characteristics additional slide, clamping unit and lubrication options have an effect on the working stroke or cylinder length. These characteristics are taken into account in the configuration. Further details ➔ B.2.5.

Error texts
The message texts for the error numbers are stored in the CMAX and can be read out via fieldbus to show them on an operating or display device. The texts are available in German and English. Advantage: The message texts do not have to be maintained separately on the controller, but are up-to-date in every future firmware version. The language is parameterised in the plug-in on the “Controller” page.

Identification characteristic values
At the end of identification, characteristic values are determined for achievable accelerations and decelerations. Previously, maximum values were determined here in which two strokes of 80 % of the working stroke were executed in the autoprofile. But the values actually achievable depend very strongly on the start and target position. To determine realistic results, average values for acceleration and deceleration are determined for V2.2 and higher. Shorter strokes are used in the free profile for that purpose. See ➔ 3.1.1 and ➔ 3.2.3.

Further improvements of the firmware
– For homing, the workpiece mass used can now be configured. Plug-in page “Homing” -› payload (PNU 1134).
– The force ramp can be parameterised up to 100,000 N/s. Large but short-stroke cylinders can reach a force ramp above 10,000 N/s.
– The standstill control can be switched off.
– When CPOS.JOGP/CPOS.JOGN is reset, jog operation is ended with the configured delay and no longer with the stop delay.
– The error E58 has been extended by further causes and so is formulated more generally as a “handshake error”. The concrete cause for E58 can be determined in the online tab “Diagnostics”, “Active Messages” tab or by reading out the diagnostic memory.
– Additional digital signals are available in the diagnostic function “Record Measurement Data”.
– The following error feedback signal (status bit SPOS.DEV) has been optimised in some special situations.

Plug-in improvements

The following points are supported by the plug-in independently of the firmware design used.

– Fast communication of the FCT plug-in via the Ethernet interface of the bus node used. Search function of the set IP address in the connected network. If a user has a secure access to the Internet in his or her network, a remote diagnosis through the Internet is possible.
– If the recommended load limits of the drive are exceeded or fallen short of during configuration of the basic load and payload, the plug-in issues a corresponding warning.
– Shift between short and long texts in the online tab “I/O Data”. That simplifies allocation of the terms used.
  Example CCON.Bit0: “Drive enabled” or “ENABLE”.
– In some situations (e.g. after a device data reset, error E72, E73, E74), a restart of the entire CPX terminal is necessary. The new reset function “Restart CPX terminal” permits a restart without switching off the supply voltage. (Menu [Component] [Restart CPX terminal]).
– With the “Upload Project” button on the second page of the assistant for hardware comparison, the CMAX project can be loaded into the FCT project without having to run through the entire assistant.
– An explanatory text can be assigned to the measurement data. This permits a fast and simple documentation of the observed behaviour.
– Improved user-friendliness with use of the displacement encoder MME-MTS and the drive DGPI. The measuring system offset of 28 mm is now automatically taken into account by the plug-in; an additional offset correction of the axis zero point and of the cylinder and measuring system length is no longer required. Further details ➔ B.2.3.

A.5.2 Firmware Design 1.9

Firmware design 1.9 requires at least the plug-in of version 1.8.0.

Error E55 is suppressed

With use of electronic safety relays to safely switch the load voltage on and off, the self-tests of these relays can trigger error E55 (Drop in load voltage: The output of the power supply unit is not sufficient). This results in necessary, but undesired error handling in the higher-order controller.
In firmware design 1.9, error E55 is suppressed.

A.5.3 Firmware Design 1.8

Firmware design 1.8 requires at least the plug-in of version 1.8.0.
Information on the most important changes follows here:

Support of further drives and adjustments of predefined measuring system lengths and limit values
Supported are the new drives DDPC and DDLI as well as size 63 of the DSMI.
Additionally, predefined measuring system lengths and limit values are adjusted.

The following characteristics of firmware design 1.1 have been improved in firmware 1.8
- If the payload has been changed in two immediately following force commands, the transition involved increased valve activity.
- If the continuous setpoint mode was activated with the first positioning command after switch-on, this could lead to uncontrolled movement into the end position.
- If the current positioning command was interrupted by a new positioning command, in rare cases this could cause the target position to be approached too fast.
- Improvement of the trace function, in particular the resolution of force signals.

A.5.4 Firmware Design 1.1

Firmware design 1.1 requires at least the plug-in of version 1.1.0.
Information on compatibility and the most important changes follows here:

New error message E47
The homing or identification may only be started when the Motion Complete is set (MC=1). If not, error E47 is produced.
This change makes the handshake between the higher-order controller and CMAX more unique.

Improved handshake in the parameterisation operating mode for cyclical I/O data
If the controller activates the parameterisation operating mode, the CMAX no longer automatically sets the input data to 0. These changes make the handshake between controller and CMAX more unique.

Valve error in case of momentary interruption of the supply voltage corrected
In case of a power supply unit that is too weak or corrects too slowly, a valve error (red LED) can occur under certain parameters without the CMAX reporting an error. Positioning commands are not carried out.

Defective homing
For large drives and/or large loads in vertical mounting position, the necessary monitoring times were not sufficient. The robustness of the homing procedure has been increased.

Change in the handshake START/ACK or HOME/ACK with operation enable (STOP)
The signals CPOS.START (bit B1) and CPOS.HOM (bit B2) must still be reset (= 0) when setting the operation enable (CCON.ENABLE) in the status byte SCON. If not, the new error E58 or new warning W58 is generated (configurable).
The following diagrams a) to c) show the various cases.

Note
The sequence corresponding to a) must also be observed after an error. Always set CPOS.START = 0 and CPOS.HOM = 0 before acknowledging the error.

a) The error-free time sequence of the control signals CCON.ENABLE, CPOS.STOP, CPOS.START/HOM:

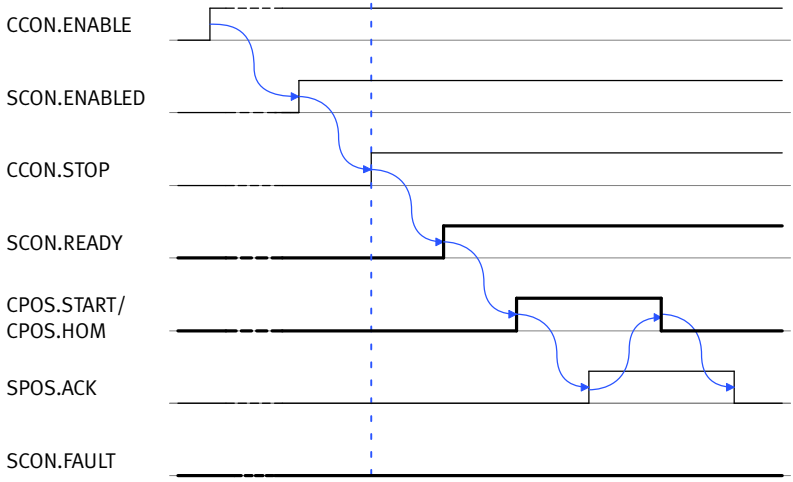


Fig. A.7 Error-free sequence of control signals

b) Incorrect time sequence: CPOS.START or CPOS.HOM (homing, start reference travel) is already set when CCON.STOP is set:

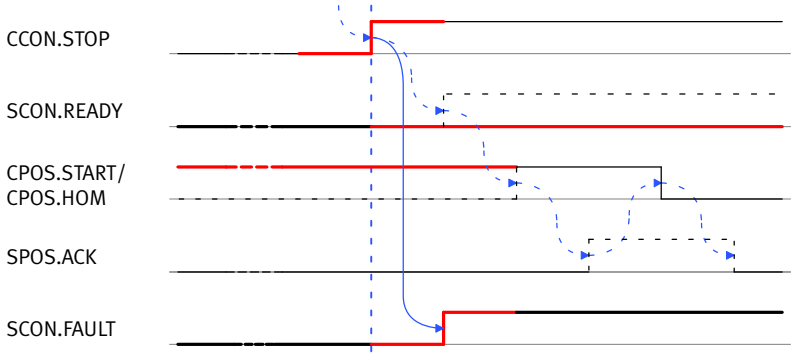


Fig. A.8 Incorrect sequence of control signals – error

The situation generates the error E58. CPOS.START/CPOS.HOM is already or still set.
Note: First reset CPOS.START/CPOS.HOM, then acknowledge the error.

c) Incorrect time sequence, like (b), but configured as a warning:

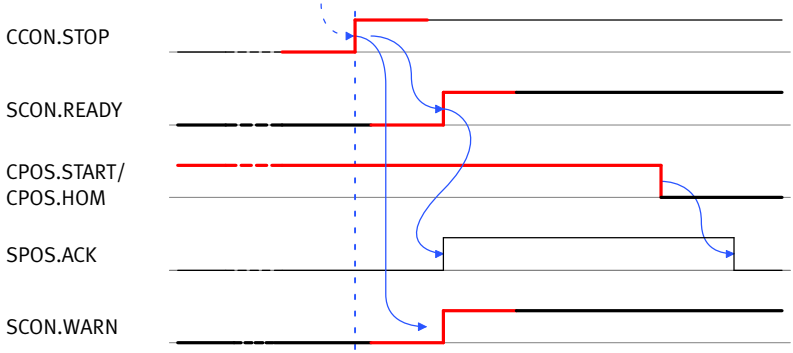


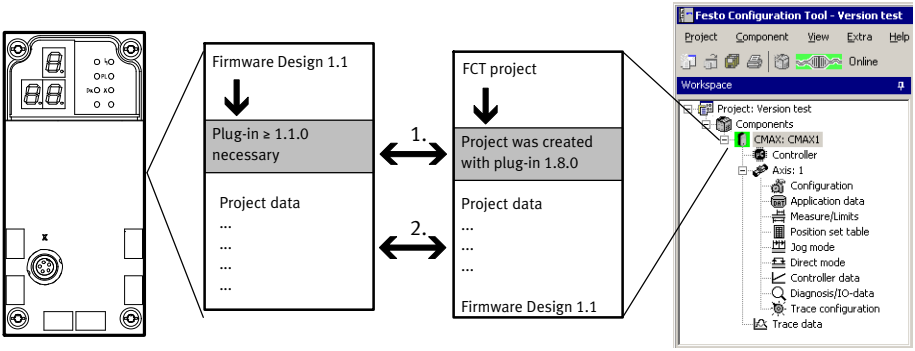
Fig. A.9 Error-free sequence of control signals – warning

The situation generates the warning W58. With revocation of CPOS.START/HOM, SPOS.ACK is reset and a positioning command can be started. The warning is deleted with the START edge.
Note: After an error, always ensure that CPOS.START/HOM are reset (= 0) before acknowledging the malfunction.

A.5.5 Firmware Design 1.0

Firmware design 1.0 is the first approved version and requires at least the plug-in of version 1.0.1. This version is completely described in the descriptions for the CMAX with the version 0908NH.

A.6 Relationship between project, CMAX and plug-in



The CMAX includes:
- Firmware design
- Necessary plug-in version for the available firmware
- Project Data

The project in the FCT includes:
- Information of the firmware of the CMAX to which the project was loaded.
- Plug-in version with which the components in the project were created (when the project is opened, the corresponding plug-in version is automatically called up)
- Project data

Fig. A.10 Relationship between project, CMAX, plug-in (example firmware 1.1 with plug-in 1.8.0)

The following are checked when the linkage is created:
1. Does the plug-in used have the necessary version for the firmware?
2. If so, the project data are compared.
3. If not, the plug-in is rejected. A message is displayed in the “Output” window.

Note: The firmware design itself will not be compared.

– If the plug-in used in the project does not have the required version, that is, does not fulfil the minimum request of the CMAX, no linkage is created.
  The plug-in reports this with a “Plug-in version conflict” and generates an entry in the “Output” window ➔ Fig. A.11. The currently used plug-in version is displayed in the status bar at the lower right.

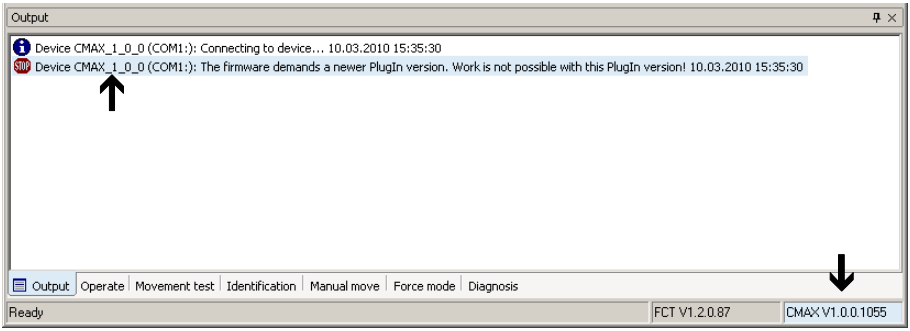


Fig. A.11 Display of the plug-in version used

– As soon as a linkage has been successfully created, the plug-in versions demanded by the CMAX are displayed on the “Controller” page in the “Compatibility” register ➔ Fig. A.12.

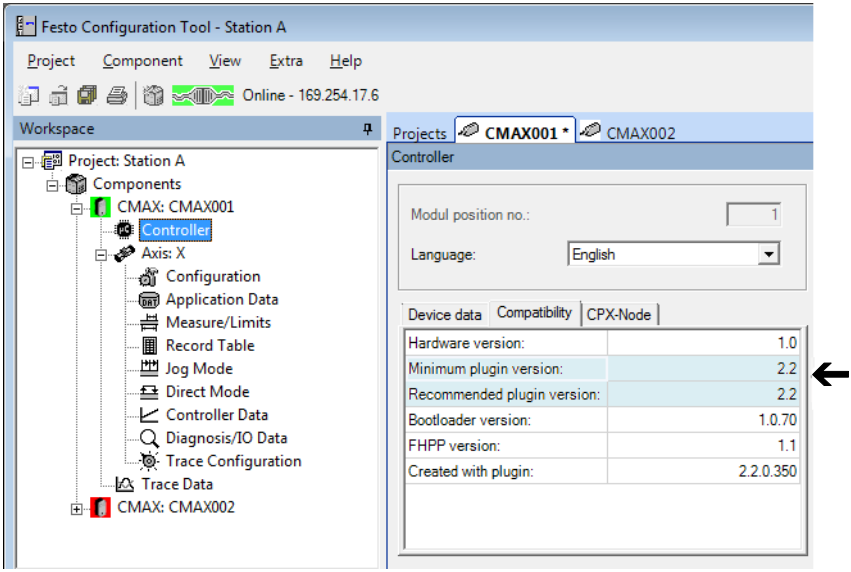


Fig. A.12 Display of the versions on the “Controller” page

A.7 FAQs on the firmware and plug-in versions

Where do I find the information on the versions of my system?

A list of the newest versions of the installed plug-ins can be displayed with the command [Help] [Information on installed plug-ins].

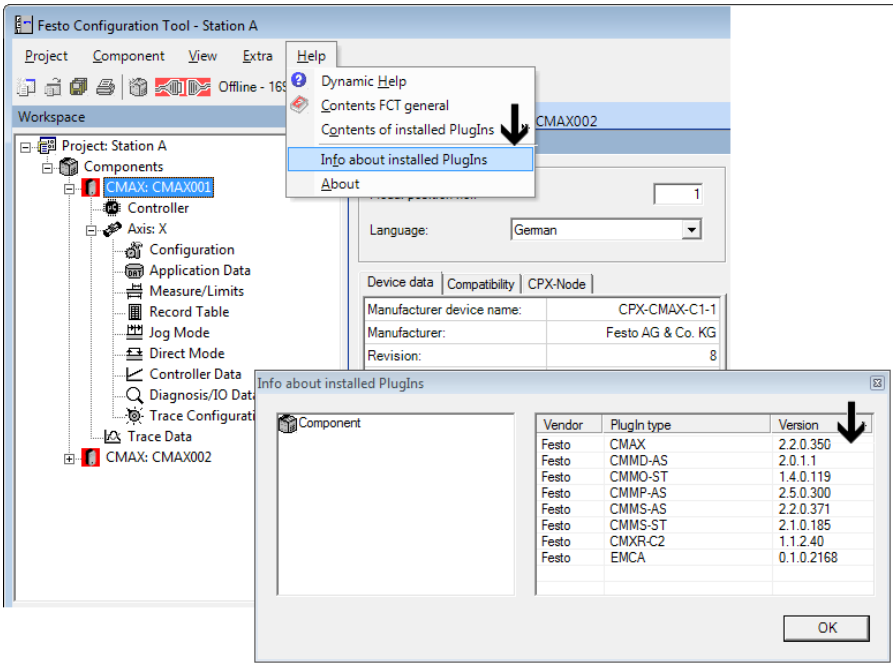


Fig. A.13 Information on installed plug-ins

When adding a new component, select the desired version ➔ Fig. A.15.
The plug-in with which the CMAX component was produced in the project is displayed on the “Controller” page in the “Compatibility” register ➔ Fig. A.12.
As soon as a linkage has been successfully created, the firmware design of the CMAX is displayed on the “Controller” page in the “Device data” register; the currently used plug-in version is displayed in the status bar of the FCT window ➔ Fig. A.14.

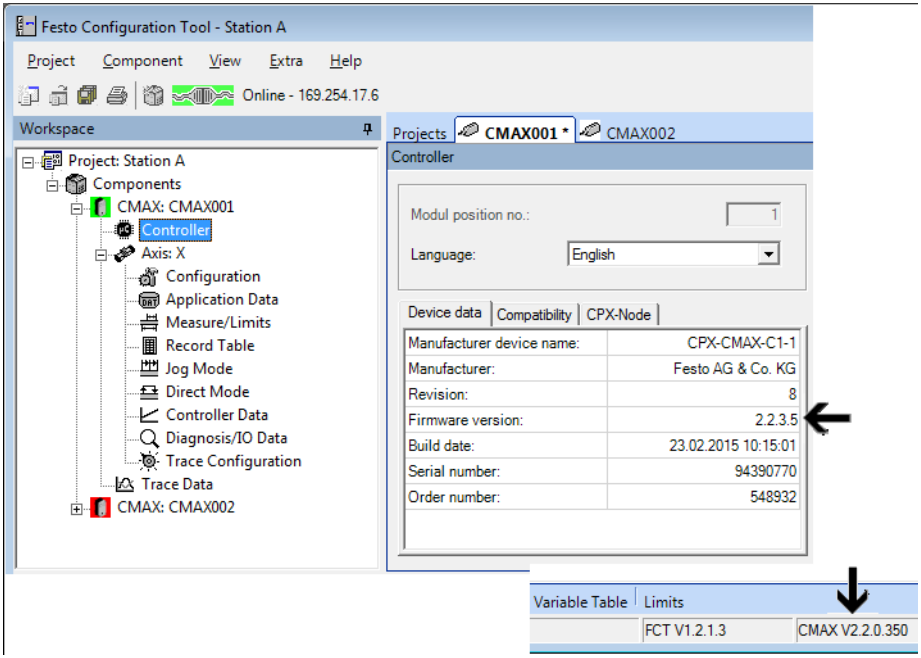


Fig. A.14 Display of the firmware design and the plug-in version used

Can I open an old project with a new plug-in?

A component in a project created with an old plug-in cannot be updated to a new plug-in.
But an upload from a connected CMAX is possible ➔ Following topic.

How do I load an old project into a new CMAX?

This is possible if the old CMAX is available. The old project must first be loaded into the old CMAX. The create a component with the new plug-in and upload the project data from the old CMAX into the project ➔ Topic “How can I load a project from an old CMAX into a new plug-in?”.
Note: If you would like to carry out a firmware update, pay attention to the notes in ➔ Section A.8.
Tip: The project data from the old project can be saved with the function “Export PNU table” and then loaded into a new project with “Import PNU table” (➔ Online help for the plug-in). With these functions, no CMAX is necessary as a “buffer”.

Can I use an older plug-in in a new project?
Festo generally recommends the use of the newest plug-in version.
To use an older plug-in version, it can be selected when a new component is inserted into the project:

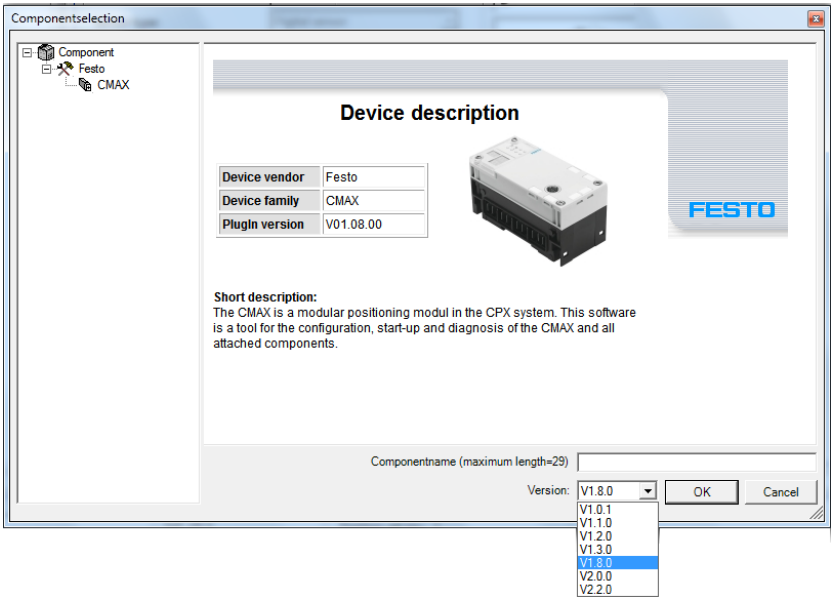


Fig. A.15 Selection of the plug-in version when adding a new component

Can I load a project created with plug-in 2.2 into a CMAX with firmware 1.1?
This is possible without any problem. Features not supported by the old firmware cannot be used.

How do I load the new firmware into a CMAX with older firmware?
Load new firmware file from the Support Portal: ➔ www.festo.com/sp. Then continue as described in ➔ Section A.8.

Can an old firmware be loaded into a new CMAX?
That is possible. Load the old firmware file from the Support Portal: ➔ www.festo.com/sp. Then continue as described in ➔ Section A.8.

How can I load a project from an old CMAX into a new plug-in?
Each plug-in supports all previously published firmware designs. In the project, a component must be created with the new version. When the linkage is activated, the Hardware Synchronisation Assistant is automatically displayed, with which the project data from the CMAX can be taken over into the project ➔ Section A.8, step 3.

A.8 Procedure for firmware update

This description refers to an upgrade of the firmware in an existing system. The existing data of the CMAX used are taken over.

A.8.1 Overview of the necessary steps for the firmware download

1. The desired firmware file must be present. It can be loaded from the support portal ➔ www.festo.com/sp, search term: “CPX-CMAX-C1-1”. The firmware files are loaded in a packed file and must be unpacked before import into FCT. Included with the firmware files is a “read me” file, which includes information about the latest changes and about the required plug-in.
2. The required plug-in must be installed on the PC. It can also be loaded from the support portal. Recommendation: Always use the newest plug-in. After the download, the setup must be executed (e.g. Setup_CMAX_V1_8_0_11.exe).
3. Bring the system into a safe status. Reset to 0 all output data of the CMAX controller, i.e. byte 1 ... 8. The controller must not block access for the FCT. Recommendation: The controller should be switched into the stop status. If possible, physically disconnect the bus connection to the CPX terminal, i.e. pull out the bus cable at the CPX terminal.
4. Create a new project in the FCT and add there a CMAX component with the new plug-in.
5. Make the connection to the CMAX with this component. The Hardware Synchronisation wizard is shown. The complete project can be read out there with the “Upload Project” button. Save the project after it is read out.
6. Opening the firmware download dialogue: [Menu component] [Firmware download].
7. Import of the desired firmware file.
8. Execute firmware download. The download times are between 3 and 40 minutes, depending on the bus node used.
9. Make the connection to the CMAX after completion of the download. The Configuration wizard is opened. If the project was previously read out, it can be transferred completely to the CMAX again with the “Download Project” button.
10. Before further commissioning, check whether new settings or parameters must be adjusted.
11. Continue with commissioning: Execute movement test, homing (for DNCI/DDPC) and identification.

A.8.2 Explanations for the individual steps

Adding new CMAX component

Create a new project and add a component with the new plug-in. Do not add the new component to the old project, since this could cause a conflict of name with the existing component.

When adding, select the desired version of the plug-in. The newest plug-in version is used as standard (➔ Fig. A.16). If the plug-in version required for the new firmware cannot be selected, the newest plug-in must be installed first.

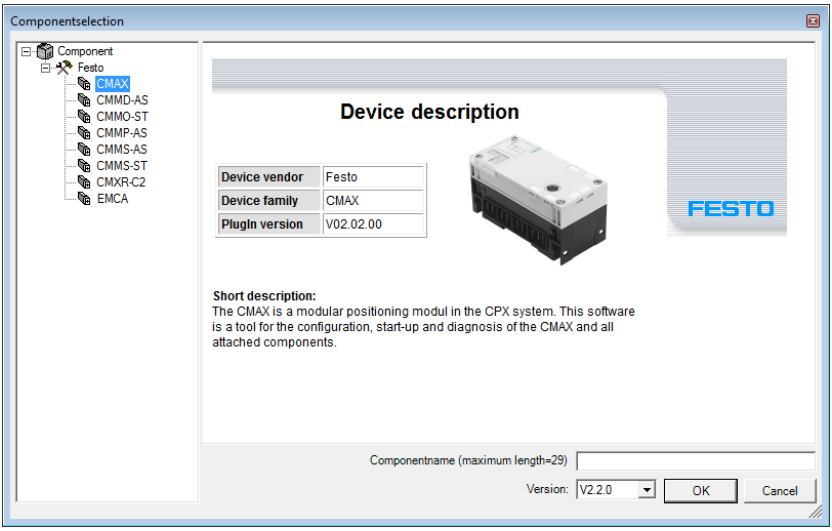


Fig. A.16

Saving the CMAX data

Activate the equipment linkage to save the existing data. After that, select the module position and synchronise the device names in case of deviation. The Hardware Synchronisation Wizard is then displayed ➔ Fig. A.17.

If that is not the case and the Configuration Assistant is displayed, no old data are present in the CMAX: Continue immediately with download of the firmware.

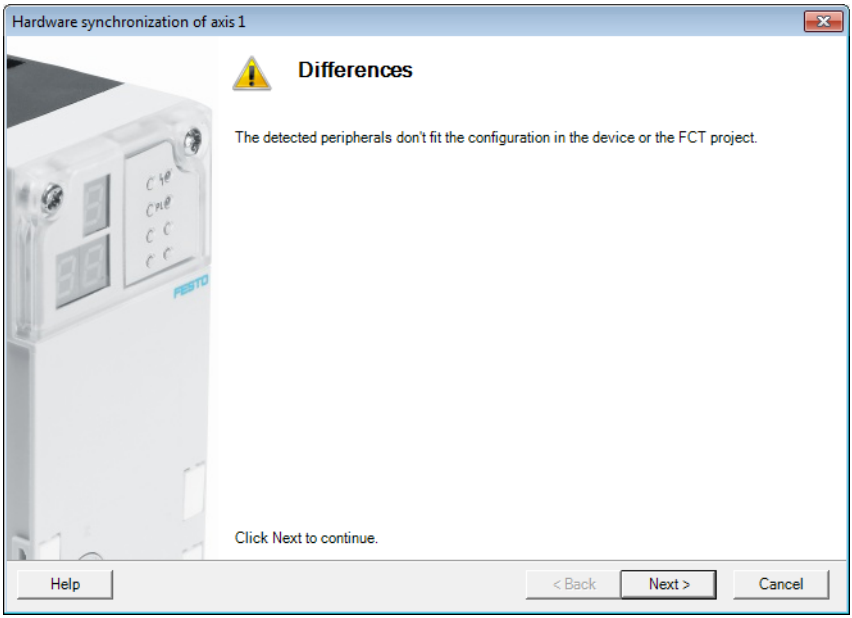

Hardware synchronization of axis 1
Differences
The detected peripherals don't fit the configuration in the device or the FCT project.
Click Next to continue.
Help
< Back
Next >
Cancel

Fig. A.17

Click on “Continue”. The comparison of the current configurations is displayed on the next page. With the “Upload Project” button, all project data are transferred from the CMAX into the new component.

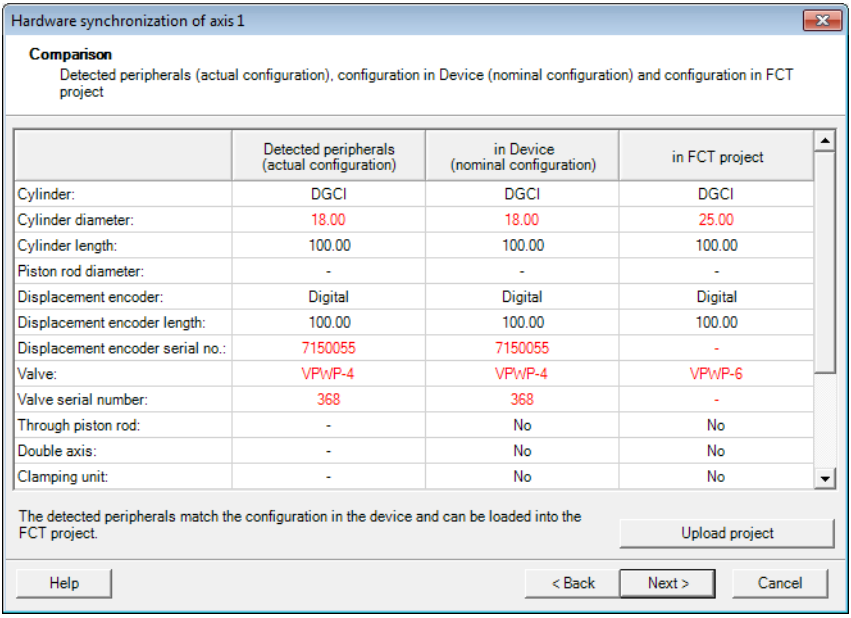

Hardware synchronization of axis 1
Comparison
Detected peripherals (actual configuration), configuration in Device (nominal configuration) and configuration in FCT project
Detected peripherals (actual configuration)
in Device (nominal configuration)
in FCT project
Cylinder: DGCI DGCI DGCI
Cylinder diameter: 18.00 18.00 25.00
Cylinder length: 100.00 100.00 100.00
Piston rod diameter: - - -
Displacement encoder: Digital Digital Digital
Displacement encoder length: 100.00 100.00 100.00
Displacement encoder serial no.: 7150055 7150055 -
Valve: VPWP-4 VPWP-4 VPWP-6
Valve serial number: 368 368 -
Through piston rod: - No No
Double axis: - No No
Clamping unit: - No No
The detected peripherals match the configuration in the device and can be loaded into the FCT project.
Upload project
Help
< Back
Next >
Cancel

Fig. A.18

Now save the project.

Downloading the firmware

In the main menu of the FCT, open the dialogue window for firmware download with [Component] [Firmware download]. All imported firmware files of the CMAX are displayed under “Available firmware files”. If the new firmware is not yet among them, use “Import” to add the firmware file from the previously used directory (BIN file, otherwise unpack before doing this).

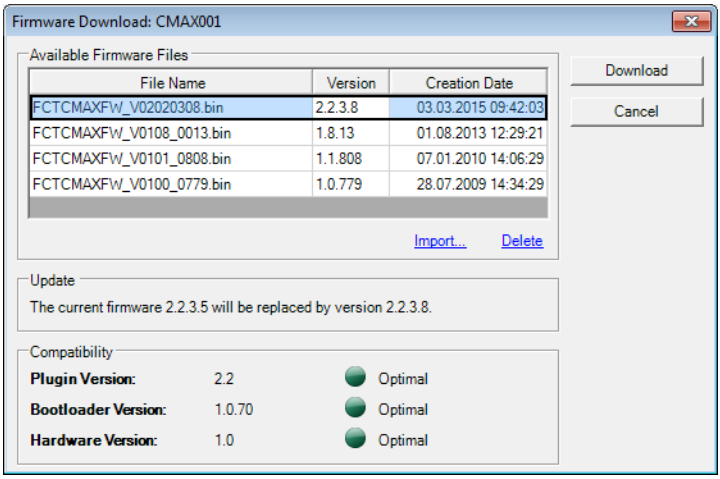


Fig. A.19

Note
The firmware download deleted all data on the CMAX. A connection to the CMAX can no longer be established with an “old” project.

Then select the desired firmware and click on download.

Restore saved data/configure new project data
After the firmware download, re-establish the linkage to the CMAX. The saved data are transferred to the CMAX with “Download project” in the Configuration Assistant.
Note: No peripheral equipment may be connected yet.

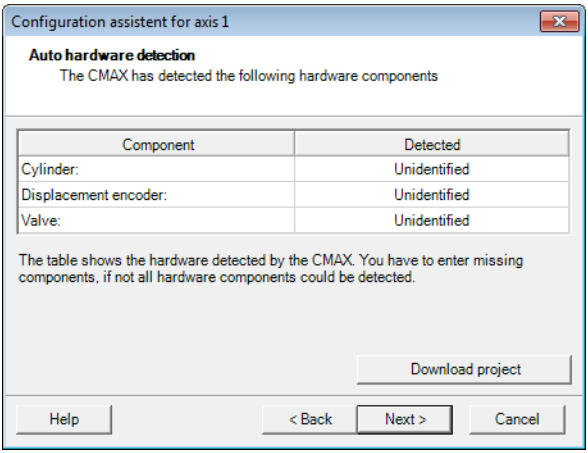


Fig. A.20

This completes the firmware download and transfer of the data.

B Basic principles of the CMAX

B.1 System of units of the CMAX

B.1.1 Definition of the system of units tables

The CMAX can either be operated in the metric/international (SI) or the imperial (inch) system of measurement units. It supports linear movements and rotational movements.
Combined, the result is 4 system of measurement unit tables for all physical and closed-loop control technology variables that can be used in the CMAX:

Selection of system of measurement units	Selection of movement (drive)	➔ System of units table
Metric/SI	Linear motion (linear drive, cylinder)	➔ Tab. B.2
	Rotation (semi-rotary drive)	➔ Tab. B.3
Imperial	Linear motion (linear drive, cylinder)	➔ Tab. B.4
	Rotation (semi-rotary drive)	➔ Tab. B.5

Tab. B.1 Possible system of units tables

Only one of the possible system of units tables is valid, and this is automatically determined through selection of the system of units and type of motion when a project is created and during download of the project data (➔ Appendix B.1.2). The system of units table actually used in the CMAX is stored in PNU 1192:06 and can be interrogated.
A system of units table always consists of 2 partial tables, one for the unit and one for the resolution/scaling. Both can be interrogated in the CMAX:
– PNU 1193: table for the units,
– PNU 1194: table for resolution/scaling.
With the system of units table, the 12 physical system variables are defined with regards to their unit and resolution, e.g. ➔ Tab. B.2.
Depending on the selected system of units (SI or Imperial) and the type of motion (linear or rotation movement), the unit can take on different values, e.g. a position or angle value (index 1 in Tab. B.2 to Tab. B.5) and so can take the unit millimetre, inch or degree.
The resolution/scaling of a physical variable describes the number of decimal places, and consequently the precision used. The resolution is specified as a 10s exponent; for example, a value of -3 means: 10^{-3}, that is, 3 decimal places.

Example of acceleration (➔ Index 7 in Tab. B.2)
PNU 1193:07 contains the value 60; this stands for the unit "metre per second squared" [m/s^2].
PNU 1194:07 contains -3 for resolution; this stands for 10^{-3}, that is, 3 decimal places.
A numerical value thus has the form XX.xxx. If, for example, the numerical value of 2550 is in PNU 541 (acceleration in direct mode), this is interpreted as 2.550 m/s^2.

System of units tables

Unit (PNU 1193)					Resolution (PNU 1194)
Index	**Physical variable**	**Value**	**Unit**	**Symbol**	
1	Position	10	Millimetre	mm	-2
2	Length	10	Millimetre	mm	-2
3	Force	20	Newton	N	0
4	Pressure	30	Bar	bar	-1
5	Mass	40	Kilogramme	kg	-1
6	Speed	50	Metre per second	m/s	-3
7	Acceleration	60	Metre per second squared	m/s^2	-3
8	Force ramp	70	Newton per second	N/s	0
9	Time	80	Millisecond	ms	0
10	Controller factor	100	– (without)	–	-2
11	Diameter	10	Millimetre	mm	-2
12	Mounting angle	15	Degree	°	-1

Tab. B.2 System of units table, linear drive – metric/SI (PNU 1192:06, value = 1)

Unit (PNU 1193)					Resolution (PNU 1194)
Index	**Physical variable**	**Value**	**Unit**	**Symbol**	
1	Angle	15	Degree	°	-1
2	Swivel angle	15	Degree	°	-1
3	Torque	25	Newton-metre	NM	0
4	Pressure	30	Bar	bar	-1
5	Mass moment of inertia	45	Kilogramme square centimetre	kg cm^2	0
6	Angular velocity	56	Degree per second	°/s	0
7	Angular acceleration	66	Degree per second squared	$°/s^2$	0
8	Torque ramp	75	Newton-metre per second	Nm/s	0
9	Time	80	Millisecond	ms	0
10	Controller factor	100	– (without)	–	-2
11	Diameter	10	Millimetre	mm	-2
12	Mounting angle	15	Degree	°	-1

Tab. B.3 System of units table, semi-rotary drive – metric/SI (PNU 1192:06, value = 3)

Unit (PNU 1193)					Resolution (PNU 1194)
Index	**Physical variable**	**Value**	**Unit**	**Symbol**	
1	Position	11	Inch	in	-3
2	Length	10	Millimetre[1)]	mm	-2
3	Force	22	Pound-force	lbf	0
4	Pressure	33	Psi	psi	0
5	Mass	41	Pound	lb	0
6	Velocity	51	Feet per second	ft/s	-2
7	Acceleration	61	Feet per second squared	ft/s^2	-2
8	Force ramp	72	Pound-force per second	lbf/s	0
9	Time	80	Milliseconds	ms	0
10	Controller factor	100	– (without)	–	-2
11	Diameter	10	Millimetre[1)]	mm	-2
12	Mounting angle	11	Degrees	°	-1

1) In the FCT, additional display in inches

Tab. B.4 System of units table, linear drive – Imperial (PNU 1192:06, value = 2)

Unit (PNU 1193)					Resolution (PNU 1194)
Index	**Physical variable**	**Value**	**Unit**	**Symbol**	
1	Angle	15	Degrees	°	-1
2	Swivel angle	15	Degrees	°	-1
3	Torque	26	Pound-force foot	lbf-ft	0
4	Pressure	33	Pound per square inch	psi	0
5	Moment of inertia	47	Pound-force square inch	$lb\ in^2$	-1
6	Angular velocity	56	Degrees per second	°/s	0
7	Angular acceleration	66	Degrees per second squared	$°/s^2$	0
8	Torque ramp	76	Pound-force-foot per second	lbf ft/s	0
9	Time	80	Milliseconds	ms	0
10	Controller factor	100	– (without)	–	-2
11	Diameter	10	Millimetre[1)]	mm	-2
12	Mounting angle	15	Degrees	°	-1

1) In the FCT, additional display in inches

Tab. B.5 System of units table, semi-rotary drive – Imperial (PNU 1192:06, value = 4)

B.1.2 Activation of the system of units table

The CMAX does not have any system of measurement units set in the delivery status or after a data reset. In this case, the display shows the status “C00” when switched on.
The system of measurement must first be defined. This is done by writing the PNU 1192:05 with value 1 or 2. With the FCT, this is done correspondingly through the Configuration Assistant.
Then the CMAX takes on the status “C01”. Configuration of the drive type (in the “C01” status) determines whether the system of units is used for a linear or rotational movement (➔ Appendix A.1.2, Fig. A.1).
Only after these 2 steps have been completed are the remaining parameters set up correspondingly; for example, the actual configuration is scaled in the established measurement units, specification values are set and access to the other parameters is allowed.

The units thus defined are used for all numerical values, also for the primary setpoints and actual values in the I/O data.

You cannot switch back and forth between the different systems of units. To change the system of units, an axis data reset must be performed. Then a new commissioning can be carried out with the new system of units.

B.1.3 Reference table and conversion of the measuring units

Unit of measurement (PNU 1193)						
Index	**Physical variable**	**Drive[1)]**	**Value**	**Unit**	**Symbol**	**Conversion**
1	Position (angle)	L	10	Millimetre	mm	= 0.03937 in
		L	11	Inch	in	= 25.4 mm
		D	15	Degree	°	–
2	Length (swivel angle)	L	10	Millimetre[3)]	mm	= 0.03937 in
		D	15	Degree	°	–
3	Force (torque)	L	20	Newton	N	= 0.22481 lbf
		L	22	Pound-force	lbf	= 4.44822 N
		D	25	Newton-metre	Nm	= 0.73756 lbf ft
		D	26	Pound-force foot	lbf-ft	= 1.35582 Nm
4	Pressure	A	30	Bar	bar	= 100 000 Pa
		A	33	Pound per square inch	psi	= 0.06895 bar

1) Drive type: A=All, L=Linear, D=Rotary/Semi-rotary drive

2) In FCT: Display/entry in mm and additional display in inches in parentheses

Unit of measurement (PNU 1193)						
Index	**Physical variable**	**Drive[1)]**	**Value**	**Unit**	**Symbol**	**Conversion**
5	Mass (mass moments of inertia)	L	40	Kilogramme	kg	= 2.20462 lb
		L	41	Pound	lb	= 0.45359 kg
		D	45	Kilogramme square centimetre	kg cm^2	= 23.73036 * 10^{-4} lb ft^2
		D	47	Pound force square inch	lb in^2	= 2.9264 kg m^2
6	Speed (angular speed)	L	50	Metres per second	m/s	= 3.28084 ft/s
		L	51	Feet per second	ft/s (fps)	= 0.3048 m/s
		D	55	Degrees per second	°/s	–
		D	56	1000 degrees per second	1000°/s	–
7	Acceleration (angular acceleration)	L	60	Metres per second squared	m/s^2	= 3.28084 ft/s^2
		L	61	Feet per second squared	ft/s^2	= 0.3048 m/s^2
		D	65	Degrees per second squared	$°/s^2$	
		D	66	1000 degrees per second squared	$1000°/s^2$	
8	Force ramp (torque ramp)	L	70	Newton per second	N/s	= 0.22481 lbf/s
		L	72	Pound-force per second	lbf/s	= 4.44822 N /s
		D	75	Torque per second	Nm/s	= 0.73756 lbf ft/s
		D	76	Pound-force-foot per second	lbf ft/s	= 1.35582 Nm/s
9	Time	A	80	Millisecond	ms	–
			81	Second	s	–
10	Controller factor	A	100	– (without)	–	–
11	Diameter	A	10	Millimetre[3)]	mm	= 0.03937 in
12	Mounting angle	A	15	Degree	°	–

1) Drive type: A=All, L=Linear, D=Rotary/Semi-rotary drive

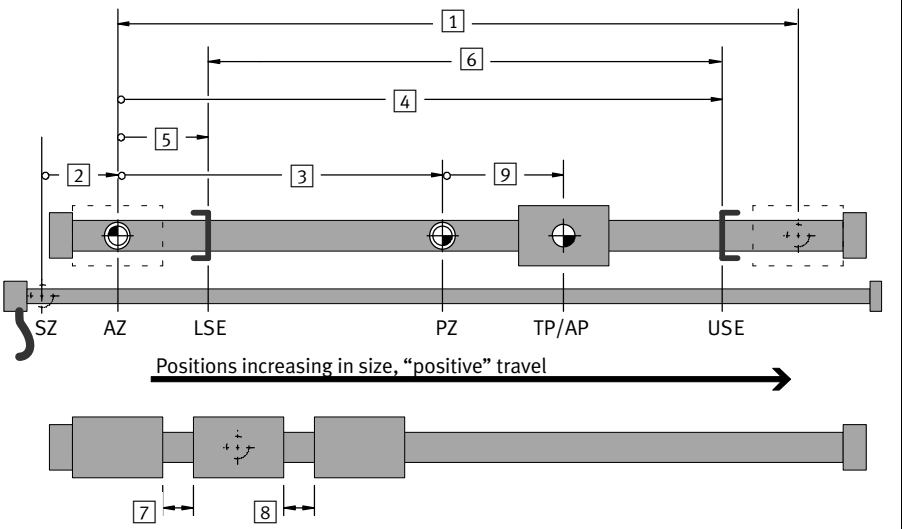
2) In FCT: Display/entry in mm and additional display in inches in parentheses

Tab. B.6 Measuring units with conversion

B.2 Dimension reference system for pneumatic drives

B.2.1 Dimension reference system with absolute displacement encoder

Dimension reference system for linear drives with absolute displacement encoder



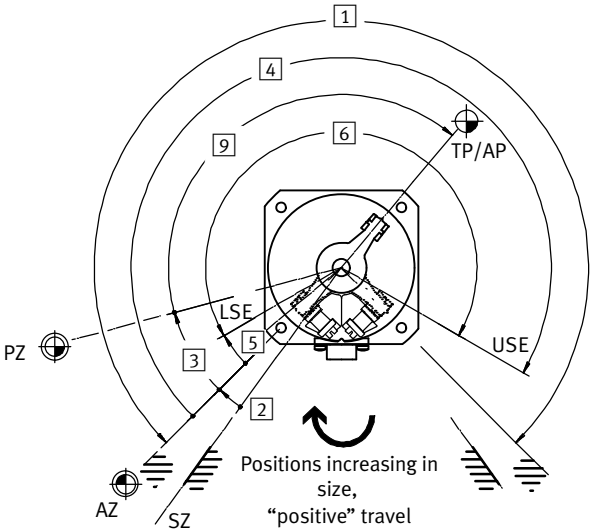
1	Working stroke	AZ, SZ	Axis zero point = sensor- / measuring system zero point
2	Offset axis zero point (a')		
3	Offset project zero point (b)[1)]	PZ	Project zero point
4	Offset upper software end position (d)[1)]	USE	Upper software end position
5	Offset lower software end position (e)[1)]	LSE	Lower software end position
6	Working stroke	TP, AP	Target position, actual position
7	Distance between slide and additional slide KR (f)[1)]		
8	Distance between slide and additional slide KR (g)[1)]	9	Offset target/actual position (c)

1) User specifications, provided these cannot be recognised (e.g. cylinder and measuring system length with the DGCI)

2) User specifications for additional options ➔ Section B.2.5

Tab. B.7 Dimension reference system for linear drives

Dimension reference system for semi-rotary drive DSMI



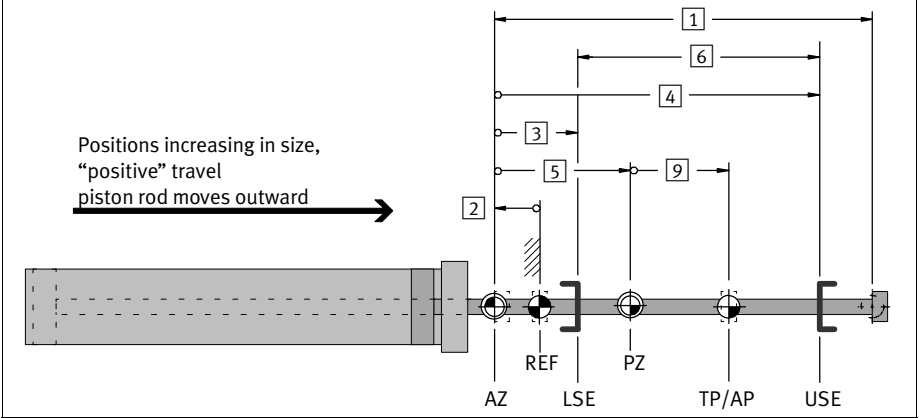
1	Working stroke	SZ	Measuring system zero point
2	Offset axis zero point (a')[1)]	AZ	Axis zero point
3	Offset project zero point (b)[1)]	PZ	Project zero point
4	Offset upper software end position (d)[1)]	USE	Upper software end position
5	Offset lower software end position (e)[1)]	LSE	Lower software end position
6	Working stroke	TP, AP	Target position, actual position
9	Offset target / actual position (c)		

1) User specifications

Tab. B.8 Dimensional reference system, DSMI

B.2.2 Dimensional reference system with incremental displacement encoder

Dimensional reference system with incremental displacement encoder



1	Working stroke	SZ	Measuring system zero point
2	Offset axis zero point (distance AZ – REF, a)[1)]	AZ	Axis zero point
3	Offset project zero point (b)[1)]	PZ	Project zero point
4	Offset upper software end position (d)[1)]	USE	Upper software end position
5	Offset lower software end position (e)[1)]	LSE	Lower software end position
6	Working stroke	TP, AP	Target position, actual position
9	Offset target / actual position (c)		

1) User specifications

Tab. B.9 Dimension reference system for pneumatic drives with incremental displacement encoder (example of homing negative stop)

B.2.3 Calculating specifications for the measuring reference system

Axis zero point and cylinder zero point

The axis zero point must always be on the cylinder zero point for servo-pneumatic linear drives!

The cylinder zero point is the mechanical stop of the drive in a negative direction.
This is necessary because the controller requires the absolute piston position within the cylinder. This means that the offset axis zero point (vector a or a') must always be specified.

Points of reference for absolute measuring systems

Point of reference	Calculation rule			
Axis zero point	AZ	= SZ + a'		
Project zero point	PZ	= AZ + b	= SZ + a' + b	
Lower software end position	LSE	= AZ + d	= SZ + a' + d	
Upper software end position	USE	= AZ + e	= SZ + a' + e	
Target/actual position	TP, AP	= PZ + c	= AZ + b + c	= SZ + a' + b + c

Tab. B.10 Calculating rules for the dimension reference system with absolute measuring systems

Note on absolute displacement encoders

When calculating for drives with an absolute encoding displacement encoder (only pneumatic), the axis zero point refers to the measuring system zero point (sensor zero point, a' instead of a). All other derived variables are identical.
Special features with use of additional options ➔ Section B.2.5.

Points of reference for incremental measuring systems

Point of reference	Calculation rule			
Axis zero point	AZ	= REF + a		
Project zero point	PZ	= AZ + b	= REF + a + b	
Lower software end position	LSE	= AZ + d	= REF + a + d	
Upper software end position	USE	= AZ + e	= REF + a + e	
Target/actual position	TP, AP	= PZ + c	= AZ + b + c	= REF + a + b + c

Tab. B.11 Calculation rules for the measuring reference system with incremental measuring systems

Note on incremental measuring systems

The "offset axis zero point" must always be specified as a negative due to the definition of the axis zero point = cylinder zero point.

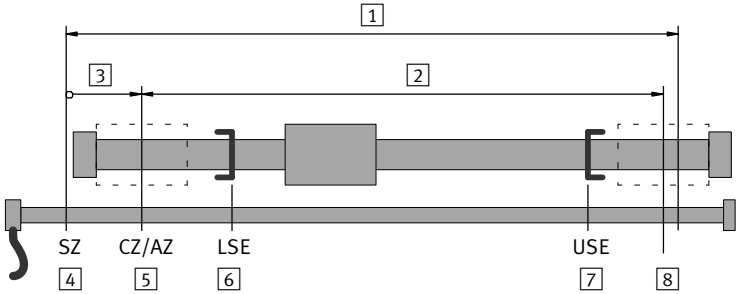
Special case digital measuring system MME (external or with user-defined drive, e.g. for DGPI)
An additional offset axis zero point of 28 mm must always be considered (in addition, the internal measurement system length must always be 28 mm longer that the specification on the rating plate. During parameterisation with the FCT plug-in, this is automatically calculated and transferred by the plug-in.

Parameter	**Plug-in => CMAX (plug-in writes)**	**CMAX => plug-in (plug-in reads)**
Measuring system length (ML)	ML (CMAX) = ML (user) + 28.00 mm	ML (user) = ML (CMAX) – 28.00 mm
Offset axis zero point (AZ)	AZ (CMAX) = AZ (user) + 28.00 mm	AZ (user) = AZ (CMAX) – 28.00 mm
Example:		
Parameter	Value in the plug-in (displayed)	Value in the CMAX (transferred)
Measuring system length	500.00 mm	528.00 mm
Offset axis zero point	12.00 mm	40.00 mm

Tab. B.12 Calculation of digital measuring system MME (external or with user-defined drive, e.g. for DGPI)

B.2.4 Software end positions / Hardware end positions

The software end positions may only be set within certain limits depending on the projected hardware. The parameters as shown in Fig. B.1 will be taken into account.



1 Measurement system length: PNU 1111
2 Cylinder length: PNU 1101
3 Offset axis zero point: PNU 1130
4 Measurement system zero point
5 Lower hardware end position
= minimum permissible lower software end position
6 Lower software end position: PNU 501:01
7 Upper software end position: PNU 501:02
8 Upper hardware end position
= maximum permissible upper software end position

Fig. B.1 Parameters for software end positions, example of linear drive with absolute measuring system

Absolute position measuring system

The limits result from the length of the displacement encoder and of the cylinder as well as the mounting offset between them. The mounting offset is given based on the offset of the measuring system zero point to the axis zero point.

Special features with use of additional options ➔ Section B.2.5.

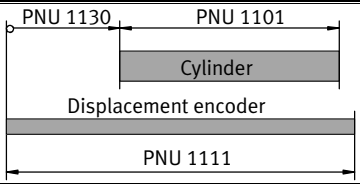
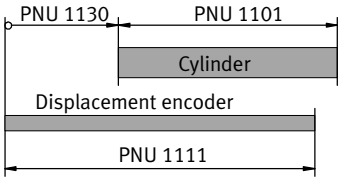
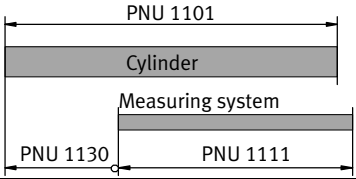
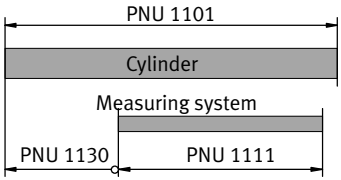
Integrated incremental displacement encoder

The limits result from the cylinder length.

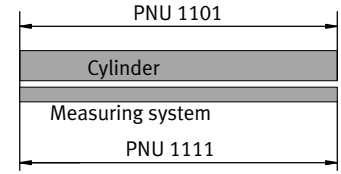
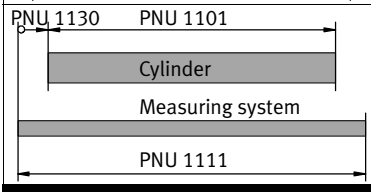
The maximum permissible limit values are referred to as “hardware end positions”. If the user sets both software end positions to 0, in order to deactivate them, all setpoint specifications are limited to the hardware end positions.

If position control is active, the set tolerance is taken into account, so that minor overswings when starting up the software end positions do not lead to an error.

Case distinction for external displacement encoder

Layout	Description
	**The measuring system projects over the cylinder on both sides** Offset axis zero point: PNU 1130 >= 0 PNU 1130 + PNU 1101 <= PNU 1111 → Min. permissible lower SWEL = 0 Max. permissible upper SWEL = PNU 1101
	**The cylinder projects over the end of the measuring system** Offset of axis zero point: PNU 1130 >= 0 PNU 1130 + PNU 1101 > PNU 1111 → Min. permissible lower SWEL = 0 Max. permissible upper SWEL = PNU1111 - PNU1130
	**The cylinder projects over the start of the measuring system** Offset of axis zero point: PNU 1130 < 0 | PNU 1130 | + PNU 1111 >= PNU 1101 → Min. permissible lower SWEL = | PNU 1130 | Max. permissible upper SWEL = PNU1101
	**The cylinder projects over the measuring system on both sides** Offset of axis zero point: PNU 1130 < 0 | PNU 1130 | + PNU 1111 < PNU 1101 → Min. permissible lower SWEL = | PNU 1130 | Max. permissible upper SWEL = | PNU 1130 | + PNU 1111

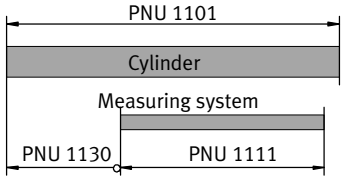
Integrated displacement encoders

Layout	Description
	**Cylinder and measuring system fully cover each other** DGCI, DDLI: Offset of axis zero point: PNU 1130 = 0 DNCI, DDPC: Offset of axis zero point: PNU 1130 <= 0 PNU 1111 = PNU 1101 → Min. permissible lower SWEL = 0 Max. permissible upper SWEL = PNU 1101
	**The measuring system projects over the cylinder on both sides** DSMI: Offset of axis zero point: PNU 1130 = 5° ... 15° PNU 1130 + PNU 1101 <= PNU 1111 → Min. permissible lower SWEL = 0 Max. permissible upper SWEL = PNU 1111

Configuration using FCT

As a specification, the software end positions in FCT are deactivated. The specification of PNU 501:01 = PNU 501:02 = 0 will deactivate the software end positions. However, the CMAX limits setpoint specifications to the maximum or minimum permissible end positions.
With the DGCI/DDLI, the axis zero point cannot be edited.

Numerical example

Layout	PNU	Description	Value
	1130	Offset axis zero point	25.5 mm
	1111	Length of the measuring system	280 mm
	1101	Length of drive	350 mm

The CMAX calculates the following limit values for the two end positions:

PNU	Description	Minimum	Maximum
501:01	Lower hardware end position, minimum lower software end position	25.5 mm	‹ Upper software end position
501:02	Upper hardware end position, maximum upper software end position	› Lower software end position	280 - 25.5 = 254.5 mm

B.2.5 Taking drive options of the DGCI into account in the dimension reference system

In the DGCI, various options can be configured that have effects on the software end positions, the working stroke, etc.

Recommendations:

– Perform initial start-up with the CMAX FCT plug-in; the plug-in takes the selected options into account.
– The optimal results in commissioning are achieved with CMAX firmware V2.2 and higher and plug-in V2.2 and higher.

Option	Description
Clamping unit -1H-PN	1-channel design, for holding loads. No stroke reduction; the drive is extended by the length of the clamping unit.
Additional slide -KL -KR -KL-KR	Additional slide for increasing the torques, optionally right, left or right and left.
Lubrication adapter -C	The lubrication adapter enables the guide to be permanently lubricated, using semi or fully automatic relubrication devices. Not usable in combination with protected recirculating ball bearing guide GP.
Protected recirculating ball bearing guide -GP	The protected guide cleans the guide rail and protects the recirculating ball bearing guide with the aid of an additional wiper and a lubrication unit.

Tab. B.13 Options for the DGCI

Each option has effects either on the stroke or the cylinder length.

– “KR” and “KL”: The additional slides reduce the working stroke. The software end positions should be set so the drive does not run into one of the stops.
– “1H”: The clamping unit does not reduce the working stroke; the drive is correspondingly longer. The controller must be parameterised in such a way that it can work properly.
– “C” and “GP”: In the case of the standard slide, the top section of the lubrication adapter and of the protected guide has space behind the fixed stops and does not reduce the stroke. But the options must be taken into account with use of the additional slide.

The options are stored in the CMAX with firmware V2.2 and higher ➔ PNU 1104, DGCI options.

Effect on parameters

PNU	Parameter	Explanation
501:1	Lower software end position	If the software end positions are not correct, the drive will travel with high speed into one of the end positions. That happens for the first time with the dynamic identification that uses the maximum working stroke. The plug-in supports the user in determining the correct software end positions.
501:2	Upper software end position	

Tab. B.14

Additional information in PNU 1190:15

Bit	Order code	Description	Values
7	–	Programmed	=1: The additional information has been programmed if at least one other bit is equal to 0. = 0: The additional information has not been programmed (production date of DGCI before mid-2015)
6	–	Reserved	= 0
5	–	Reserved	= 0
4	C	Lubrication	= 0: Standard = 1: Central lubrication
3	GP	Slide	= 0: Recirculating ball bearing guide = 1: Protected recirculating ball bearing guide
2	1H-PN	Clamping unit	= 0: Not present = 1: Present
1	KL	Additional slide, left	= 0: Not present = 1: Present
0	KR	Additional slide, right	= 0: Not present = 1: Present

Tab. B.15 Options in PNU 1190:15

Calculation

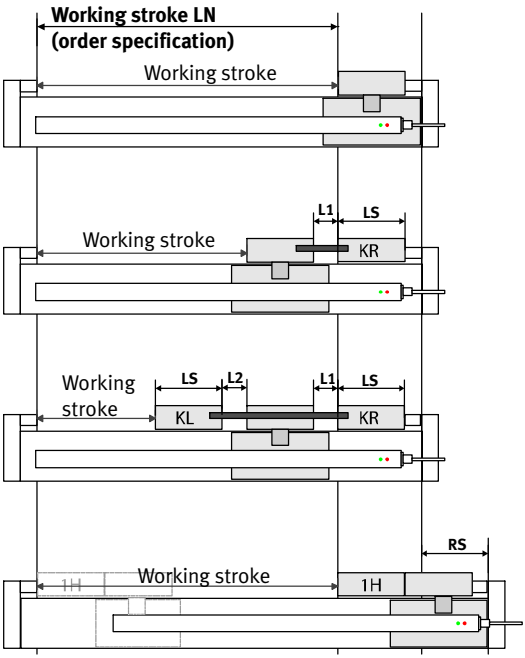


Fig. B.2 Dimensions for calculation

Piston diameter	Slide length LS [mm]			Extension LH [mm]
	Standard	-GP	-C	-1H-PN
18	99.0	120.0	–	–
25	118.5	144.0	145.0	71.0
32	145.7	173.0	172.0	70.5
40	195.4	231.0	223.0	158.0
63	280.0	–	308.4	–

Tab. B.16 Slide length and extension of the stroke dependent on the piston diameter

Option	Lower software end position (PNU 501:1)	Upper software end position (PNU 501:2)	Cylinder length[1)]
-1H-PN	0	LN	LN + LH
-KR	LS + L1	LN	LN
-KL	0	LN - (LS + L2)	LN
-KL-KR	LS + L1	LN - (LS + L2)	LN

1) The nominal length is stored in the reference configuration. The controller automatically takes into account when the option PNU 1104.1 (integrated clamping unit) is set.

Tab. B.17 Calculation of the software end positions and cylinder length (working stroke)

B.3 Drives and measuring systems

The CMAX supports the following combinations of drive and measuring system types. Selecting a different combination is not possible in the FCT and will lead to an error in the CMAX.

Approved drives ➔ System description for the CMAX.
In addition, user-defined drives can be used on consultation with Festo.

Linear drive DGCI / DDLI		
Parameter	**PNU**	**Value**
Displacement encoder	1110	Permanently specified: = digital displacement encoder
Cylinder length	1101	50 mm ... 2000 mm
Displacement encoder length	1111	Permanently specified = cylinder length ±5 mm
Offset axis zero point	1130	Permanently specified = 0
Cylinder diameter	1102	Selection for the DGCI: 18, 25, 32, 40, 63 Selection for the DDLI: 25, 32, 40, 63 User-defined: 16 ... 125
Piston rod diameter	1103	0

DNCI / DDPC standard cylinder		
Parameter	**PNU**	**Value**
Displacement encoder	1110	Permanently specified: = incremental displacement encoder
Cylinder length	1101	50 mm ... 2000 mm
Measuring system length	1111	Permanently specified = cylinder length ±5 mm
Offset axis zero point	1130	Selectable within the cylinder length
Cylinder diameter	1102	Selection for the DNCI: 32, 40, 50, 63 Selection for the DDPC: 80, 100 User-defined: 16 ... 320
Piston rod diameter	1103	Allocation[1)] for the DNCI: 12, 16, 20, 20 Allocation[1)] for the DDPC: 22.6, 22.6 User-defined: less than cylinder diameter

1) Corresponding to the sequence of the cylinder diameters

DSMI semi-rotary drive		
Parameter	**PNU**	**Value**
Displacement encoder	1110	Permanently specified: = potentiometer
Cylinder length	1101	270° ... 275°
Measuring system length	1111	285° ... 295°
Offset axis zero point	1130	Selectable within 5° ... 15°
Cylinder diameter	1102	Selection: 25, 40, 63[1)]
Piston rod diameter	1103	0

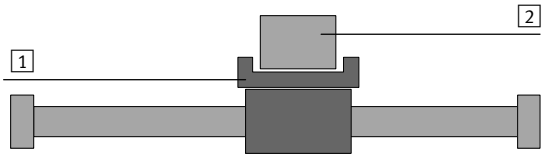
1) In the CMAX, drives with other diameters will lead to errors here.

Rodless linear drive / piston rod drive		
Parameter	**PNU**	**Value**
Displacement encoder	1110	Selectable: 1. potentiometer 2. digital displacement encoder
Cylinder length	1101	50 mm ... 2000 mm
Measuring system length	1111	50 mm ... 10,000 mm
Offset axis zero point	1130	Within the max. positioning range[1)]
Cylinder diameter	1102	16 mm ... 320 mm
Piston rod diameter	1103	Rodless linear drive: 0 Cylinder rod drive: less than cylinder diameter

1) Max. travel range: stroke between the hardware end positions. The hardware end positions describe the range where cylinder and displacement encoder overlap, i.e. where the piston can actually move.

B.4 Taking the load into account

For optimal position and force control, the controller of the CMAX needs the specifications concerning the moving masses to be as precise as possible. This must be taken into account by means of special parameters (➔ Tab. B.18).

Parameterisation of the loads	
	
1	**Base load (PNU 1142)** Payloads including piston rod, piston, slide as well as the components permanently installed on the slide. This load must always be moved by the drive (minimum load to be moved). The load of the piston rod, etc., can be taken from the catalogue information (➔ www.festo.com/sp).
2	**Payload (PNU 605/410/536/544/551/1134 ➔ Section 5.3)** If the drive also has to move workpieces of different weights, this variable share must be defined as payload. The CMAX calculates the sum of both load data for every positioning process. The respective load present is determined by specifying the changing payload (PNU 605 is the global default value). During jogging (PNU 536), direct drive (PNU 544 or 551) and homing (PNU 1134), the payload can also be specified individually in each record (PNU 410).
–	**Payload loaded at switch-on (PNU 1143:01)** When the controller is released (drive released), the last valid payload is always used. Usually no workpiece is loaded during the first enable after switch-on, so CMAX only takes into account only the base load (PNU 1142). This parameter defines whether the workpiece should also be taken into account during switch-on. 0 = Workpiece not loaded during switch-on. The workpiece is only loaded during operation. 1 = The workpiece is in the loader during switch-on.

Tab. B.18 Parameters for the load

Observe note on load when opening the clamping unit/brake ➔ Section 3.1.7.
Example for use ➔ Section 5.3.

B.5 Controller optimisation

Note
Before optimisation using the data of the position controller, the mechanical configuration must be checked ➔ CMAX system description, P.BE-CPX-CMAX-SYS-... .

From the drive configuration and the application settings, the CMAX determines the internal controller parameters amplification, cushioning and filter factor. These determine the dynamic response (speed) as well as the transition behaviour (cushioning) of the control. The goal is to guarantee fast, overswing-free positioning with low following error.
The controller data ascertained by the CMAX are usually already the optimum values. The (real) pneumatic axes used, however, do not always correspond to the axes used as a basis for the control process (ideal axes). The control parameters can be influenced by entering factors to take account of possible deviations.
With the parameters PNU 1150 ... 1152 (position controller) and 1160 ... 1162 (force controller), the internal parameters can be increased (values › 1) or reduced (values ‹ 1).

B.5.1 Controller factors for position control

Position controller amplification gain (PNU 1150)
The amplification gain influences the sensitivity with which the positioning control loop responds to changes in the “measured variables” (position, speed, acceleration).

Behaviour of the axis	Factor
The drive tends towards instability (tendency to vibrate during positioning, up to continuous vibration around the setpoint position).	Reduce
Bad positioning accuracy or high following error as well as long positioning time.	Increase
The positioning process is carried out quickly and accurately.	Optimal

Tab. B.19 Effect of position controller amplification gain

Position controller cushioning factor (PNU 1151)
Cushioning is a measure for the transition behaviour of the system from the actual to the setpoint status, especially when there are fast modifications to the setpoint value. The system should generally ensure low-vibration behaviour at the setpoint value specification and an overswing-free approach into the target position.
Modifying the factor for cushioning influences the transition behaviour of the system.

Behaviour of the axis	Factor
Bad positioning quality, nominal position is approached only slowly (underswing).	Reduce
The drive tends towards instability (tendency to vibrate during positioning, up to continuous vibration around the setpoint position, heavy overswing).	Increase
The positioning process is carried out quickly and accurately.	Optimal

Tab. B.20 Effect of position controller cushioning factor

Position control filter factor (PNU 1152)

Speed and acceleration are derived from the positioning signal and filtered to improve the signal quality. Filtering of the signal can be influenced by the filter factor if the signal quality is poor in practice, for example due to electrical interference.

If filtering is too strong, it may destabilize control.

Behaviour of the axis	Factor
The drive tends towards instability (despite low gain and good cushioning).	Reduce
"Noise" or loud valve noises (observe amplification; too high?).	Increase
The positioning process is carried out quickly and accurately, low valve noises.	Optimal

Tab. B.21 Effect of position controller filter factor

B.5.2 Optimise positioning behaviour

During identification, the positioning behaviour is automatically optimised. If the quality of the positioning behaviour still does not meet the desired requirements, at first proceed as follows:

– Check parameterisation (FCT)
– Check controller settings

Note

Incorrect parameters can destroy the drive.

- Be very careful when setting the parameters.

If fluctuations in pressure of over 1 bar occur before the proportional directional control valve, install a compressed air reservoir ➔ CMAX system description. Observe the general installation instructions!

The following problems may typically occur during positioning:

– Multiple premature stopping of the axis
– Swinging around the setpoint position
– Stability problem, very frequent swinging around the setpoint position
– Overswinging
– Underswinging

Before optimising the positioning behaviour of the axis:

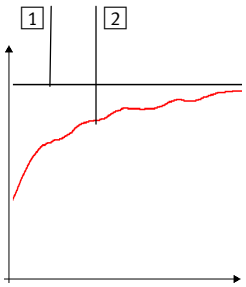
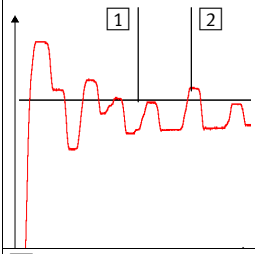
- Check whether the pneumatic axis is constructed in accordance with the regulations ➔ CMAX system description.
- Check whether all axis and application data are set correctly.
- Always carry out identification.
- Then always perform several positioning cycles. This guarantees that the adaptation is effective.

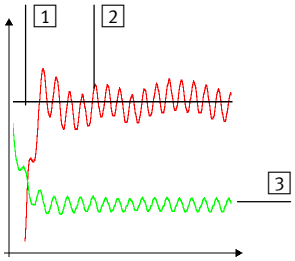
If problems still occur:

1. Observe positioning behaviour. Use the FCT plug-in for this. With the plug-in, the setpoint and actual values for path, speed and acceleration can be recorded and graphically displayed.

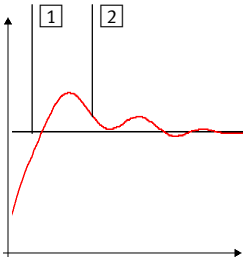
Detailed information ➔ Help for the CMAX plug-in.

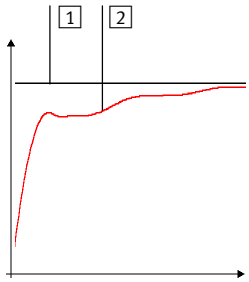
2. Compare the positioning behaviour or the graph created with the plug-in to the following examples.
3. Optimising the positioning behaviour as described in the table of the corresponding example. From top to bottom, first check the most probable causes and their remedial measures.

Effect	Cause	Remedy
Premature stop several times		
	– Identification not carried out – Adaptation is not yet completed – Bad running behaviour of cylinder/guide (stick-slip) – Incorrect load	• Carry out identification travel • Carry out some positioning cycles (adaptation) • Check, if necessary perform maintenance or replace components • Correct load
Swinging around the setpoint position with standstills		
	– Identification travel not carried out – Incorrect load configured – High running performance of cylinder (friction has changed) – Amplification gain set too low	• Carry out identification travel • Correct configuration • Carry out identification again • Correct the parameter
1 Setpoint position 2 Actual position		

Effect	Cause	Remedy
Stability problem, higher-frequency swinging around the setpoint position		
	– Incorrect load configured – Gain factor set too high – Cushioning factor set too low – Filter factor set too high (smooth acceleration/speed signal but continuous swinging) – Very noisy acceleration signal with high amplitude – Minimum load not reached – Too small tolerance demanded	• Correct configuration • Correct the parameter • Correct the parameter • Reduce filter factor • Increase filter factor • Increase base load • Increase tolerance

Effect	Cause	Remedy
	– Mechanical resonance in the machine or machine areas in which the axis is mounted	• Increase mechanical stability. Stiffen metal sheets, which tend to vibrate. • Reduce amplification gain and acceleration ramps.
1 Setpoint position 2 Actual position 3 Speed		

Effect	Cause	Remedy
Overswing (no or minimum standstills before MC)		
	– Drop in the static supply pressure in operation below the permitted tolerance limit	• Stabilize supply pressure or carry out new identification travel with lower supply pressure
	– Load too high (or configured load too low)	• Correct load
	– Overload (setpoint acceleration too high)	• Reduce setpoint values (in particular acceleration). If necessary, carry out dynamic identification travel (automatic limiting)
	– Filter factor set too high	• Correct parameter
	– Amplification gain set too high	• Correct parameter
	– Cushioning factor set too low	• Correct parameter

Effect	Cause	Remedy
Underswing (no or minimum standstills before MC)		
	– Too much load configured (possibly causes over-cushioned controller) – Overload (too high, “fast” setpoint values)	• Reduce load • Adjust setpoint values; if necessary, carry out dynamic identification travel (automatic limiting)
1 Setpoint position 2 Actual position		

B.5.3 Controller factors for force control

Force controller amplification gain (PNU 1160)

The amplification gain increases or reduces the controller amplification.

- As a result, the controller responds to deviations faster or more slowly. The time until the static final value is reached can be optimised.
- The amplification gain is used to influence path accuracy over the entire force command.
- If this factor is increased too much, the valve starts to hum. This occurs especially with a static force setpoint and with standstill control.

Behaviour of the axis	Factor
Force builds up too slowly; the static accuracy is reached only hesitantly.	Increase
Overswing occurs during force build-up. The valve tends to hum.	Reduce
The force value follows the setpoint value with few deviations.	Optimal

Dynamic amplification force controller (PNU 1161)

Dynamic amplification is only effective in the area of the force ramp, in other words, when the force setpoint changes.

- It can be used to influence the path accuracy during the force ramp.
- A modification does not affect the static accuracy.

Behaviour of the axis	Factor
During force build-up, the actual value cannot follow the setpoint value.	Increase
During force build-up, the actual value runs ahead of the setpoint value.	Reduce
The force build-up is performed fast and accurately.	Optimal

Force control filter factor (PNU 1162)

Derived signals (e.g. force ramp from the pressure signal) are filtered to improve the signal quality.

- If filtering is too strong or too weak, it may destabilise control.
- The filter factor can be used to influence the signal noise that, originating from the pressure sensors, affects the force value.
- When increasing the factor, the filter becomes faster and consequently the noise louder. At the same time, the phase shift decreases.
- The filter factor is reduced to suppress valve humming. This may be necessary, for example, if the control precision required can only be achieved by increasing the amplification gain, and so the valve tends to hum.

C Parameter

C.1 General parameter structure of the CMAX

The CMAX contains a parameter set with the following structure:

Group	PNU	Description	Section
Device data (axis-independent)			
Device data	100 ... 199	Device identification and device-specific settings, version numbers, identifier words, etc.	➔ C.2.2
Axis data			
Diagnostics	200 ... 299	Memory for diagnostic events: error and warning numbers, time stamp, active messages	➔ C.2.3
Process Data	300 ... 399	Current setpoint values and actual values, status data	➔ C.2.4
Record table	400 ... 499	For the record mode. A record includes all the setpoint value parameters required for a positioning procedure.	➔ C.2.5
Project data	500 ... 529	Fundamental project settings: project zero point, setpoint value limits for position, force, speed, ...	➔ C.2.6
Jog operation	530 ... 539	Data for jogging	➔ C.2.7
Direct mode position control	540 ... 549	Data for the direct mode with position control	➔ C.2.8
Force control in direct mode	550 ... 599	Data for direct mode with force control	➔ C.2.9
Global default values	600 ... 699	Describe global default values, function in ➔ Section 5.3.	➔ C.2.10
Drive configuration	1100 ... 1129	All axis-specific parameters for pneumatic drives: cylinder length and diameter, valve type, ...	➔ C.2.11
Application settings	1130 ... 1149	Application-specific parameters, axis zero point, mounting position, ...	➔ C.2.12
Position controller	1150 ... 1159	Controller parameters for position control	➔ C.2.13
Force controller	1160 ... 1169	Controller parameters for force control	➔ C.2.14
Identification	1170 ... 1189	Identification, adaptation	➔ C.2.15
System data	1190 ... 1199	Actual configuration, system of measurement units, data reset, ...	➔ C.2.16
Error texts	2100 ... 2199	Texts of errors and warnings	➔ C.2.17

Tab. C.1 Parameter structure

Parameter classes	Characteristic/usage
Var	Simple variable. Contains only one value. The subindex does not have a function.
Array	Contains multiple simple variables that all have the same significance, the same limits, the same unit, etc. Example: record table setpoint position (PNU 404). The components in the array are addressed using the subindex.
Struct (Record)	Summary of several single variables with different limit values, etc.

Tab. C.2 Parameter classes for the CMAX

Data types	Characteristic/usage
bit array	4-byte value whose individual bits have separate meanings
char	8-bit ASCII characters as string component[1)]
int32	4-byte integer value with sign

1) Note on strings: The CMAX checks for all strings that a Char does not contain a control character (values 0x01 ... 0x1F). For the various string objects, the plug-in has different rules that further restrict reliability. These rules are specified in the respective PNU. Strings end in each case with 0x00 (ASCII character zero).

Tab. C.3 Data types for the CMAX

C.2 Description of the parameters

C.2.1 Overview of parameters

The overview in Tab. C.5 shows the parameters of the CMAX. Description of the columns ➔ Tab. C.4. Detailed description of the parameters ➔ Sections C.2.2 to C.2.16.

Index	Physical variable
PNU	Decimal parameter number
Ind.	Subindex (Array, Struct) decimal (X = all or several subindexes of the PNU)
Max.	Max. index, largest index = array size/structure size
Class	Parameter class (Var, Array, Struct)
Type	Value type (int32, bitarray, char)
Unit	Physical unit (➔ PNU 1193 and Appendix B.1)
RW	Access, R = read only, RW = read and write, W = write only

Tab. C.4 Key on CMAX parameter overview

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
Device data (➔ Section C.2.2)							
100	1	1	Hardware version of manufacturer	Var	int32	–	R
101	1	1	Firmware version of manufacturer	Var	int32	–	R
102	1	1	Version FHPP	Var	int32	–	R
103	X	30	Date produced	Array	Char	–	R
104	X	2	Software versions	Var	int32	–	R
105	1	1	Boot loader version	Var	int32	–	R
107	1	1	Variants code	Var	int32	–	R
108	X	30	Variants name	Array	Char	–	R
114	1	1	Controller serial number	Var	Bit array	–	R
116	X	33	FCT project identifier	Array	Char	–	RW
120	X	30	Manufacturer's device name	Array	Char	–	R
121	X	30	User's device name	Array	Char	–	RW
122	X	30	Manufacturer name	Array	Char	–	R
123	X	30	HTTP address of manufacturer	Array	Char	–	R
124	X	30	Festo order number	Array	Char	–	R
130	X	30	Password	Array	Char	–	W
133	X	2	System password	Var	int32	–	RW
140	1	2	System time: operating days display	Struct	int32	–	R
140	2	2	System time: milliseconds of the day	Struct	int32	–	R

1) ➔ Tab. C.4

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
154	1	1	Language	Var	int32	–	RW
155	1	1	Supported languages	Var	Bit array	–	R
180	X	30	Axis Name	Array	Char	–	RW
Diagnostics (➔ Section C.2.3)							
200	X	100	Diagnostic event	Array	int32	–	R
201	X	100	Diagnostic code	Array	int32	–	R
202	X	100	Time stamp time of day	Array	int32	–	R
203	X	100	Additional information	Array	Bit array	–	R
204	1	5	Reserved	Struct	int32	–	R
204	2	5	Reserved	Struct	int32	–	R
204	3	5	Clear memory	Struct	int32	–	RW
204	4	5	Number of entries	Struct	int32	–	R
204	5	5	Number of unread entries	Struct	int32	–	RW
220	X	3	Active error messages	Array	Bit array	–	R
221	X	3	Current warnings	Array	Bit array	–	R
222	X	100	Time stamp: operating day	Array	int32	–	R
224	1	1	Currently shown error display	Var	int32	–	R
225	1	1	Active level	Var	int32	–	R
226	1	1	Current warning to be displayed FCT	Var	int32	–	R
227	X	89	Error status FCT	Array	Bit array	–	R
228	1	3	Diagnostic events filter	Struct	Bit array	–	RW
228	2	3	Errors and warnings filter	Struct	Bit array	–	RW
228	3	3	Fault configuration settings	Struct	Bit array	–	RW
Process data (➔ Section C.2.4)							
300	X	3	Position values	Array	int32	Position/angle	R
301	X	3	Force values	Array	int32	Force	R
302	X	3	Pressure values	Array	int32	Pressure	R
305	1	4	Count of positioning commands	Struct	int32	–	R
305	2	4	Number of force commands	Struct	int32	–	R
305	3	4	Sum of stroke lengths	Struct	int32	–	R
305	4	4	Sum of stroke lengths fraction	Struct	int32	–	R
307	1	1	Current speed	Var	int32	Speed/ angular velocity	R
308	1	1	Extended axis status	Var	Bit array	–	R
309	1	1	Valve setting value	Var	int32	–	R
Record table (➔ Section C.2.5)							
400	1	3	Target record number	Struct	int32	–	R
400	2	3	Actual record number	Struct	int32	–	R

1) ➔ Tab. C.4

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
400	3	3	Record status byte	Struct	Bit array	–	R
401	X	64	Record control byte 1	Array	Bit array	–	RW
402	X	64	Record control byte 2	Array	Bit array	–	RW
403	X	64	Record default values	Array	Bit array	–	RW
404	X	64	Setpoint value record	Array	int32	Position/angle, force	RW
405	X	64	Record preselected value	Array	int32	➔ Section 3.3.3	RW
406	X	64	Speed record	Array	int32	Speed/ angular velocity	RW
407	X	64	Acceleration record	Array	int32	Acceleration/ angular acceleration	RW
408	X	64	Deceleration record	Array	int32	Acceleration/ angular acceleration	RW
410	X	64	Payload record	Array	int32	Mass/mass moment of inertia	RW
411	X	64	Tolerance record	Array	int32	Position/angle, force	RW
412	X	64	Force ramp record	Array	int32	Force ramp	RW
Project data (➔ Section C.2.6)							
500	1	1	Offset project zero point	Var	int32	Position/angle	RW
501	1	2	Lower software end position	Var	int32	Position/angle	RW
501	2	2	Upper software end position	Var	int32	Length/swivel angle	RW
507	1	1	Stop delay	Var	int32	Acceleration/ angular acceleration	RW
510	1	1	Permitted stroke with force control	Var	int32	Position/angle	RW
511	1	1	Min. permitted force setpoint value	Var	int32	Force	RW
512	1	1	Max. permitted force setpoint value	Var	int32	Force	RW
514	1	1	Permitted speed with force control	Var	int32	Speed/ angular velocity	RW
521	1	4	Jog mode parameter control	Array	Bit array	–	RW
521	2	4	Direct mode position parameter control	Array	Bit array	–	RW
521	3	4	Direct mode force parameter control	Array	Bit array	–	RW
521	4	4	Homing default values	Array	Bit array	–	RW
522	1	2	Reserved	Struct	int32	–	RW
522	2	2	FHPP: Control/status bits: level CCON.BRAKE	Struct	int32	–	RW
523	X	8	FHPP: Setpoint/actual values	Struct	int32	–	RW

1) ➔ Tab. C.4

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
Jog operation (→ Section C.2.7)							
530	1	1	Jog mode, creeping speed	Var	int32	Speed/ angular velocity	RW
531	1	1	Jog mode, maximum speed	Var	int32	Speed/ angular velocity	RW
532	1	1	Jog mode acceleration	Var	int32	Acceleration/ angular acceleration	RW
533	1	1	Jog mode deceleration	Var	int32	Acceleration/ angular acceleration	RW
534	1	1	Jog mode time slow speed	Var	int32	Time	RW
536	1	1	Jog mode payload	Var	int32	Mass/mass moment of inertia	RW
Direct mode position (→ Section C.2.8)							
540	1	1	Direct mode position speed	Var	int32	Speed/ angular velocity	RW
541	1	1	Direct mode position acceleration	Var	int32	Acceleration/ angular acceleration	RW
542	1	1	Direct mode position deceleration	Var	int32	Acceleration/ angular acceleration	RW
544	1	1	Direct mode payload position	Var	int32	Mass/mass moment of inertia	RW
545	1	1	Direct mode position tolerance	Var	int32	Position/angle	RW
Direct mode force (→ Section C.2.9)							
550	1	1	Direct mode force force ramp	Var	int32	Force ramp	RW
551	1	1	Direct mode force payload	Var	int32	Load	RW
552	1	1	Direct mode force force tolerance	Var	int32	Force	RW
554	1	1	Direct mode force speed limiting	Var	int32	speed	RW
Global default values (→ Section C.2.10)							
600	1	1	Default value speed position control	Var	int32	Speed/ angular velocity	RW
601	1	1	Default value speed force control	Var	int32	speed	RW
602	1	1	Default value acceleration	Var	int32	Acceleration/ angular acceleration	RW
603	1	1	Default value deceleration	Var	int32	Acceleration/ angular acceleration	RW

1) → Tab. C.4

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
605	1	1	Default value payload	Var	int32	Mass/mass moment of inertia	RW
606	1	1	Default value position tolerance	Var	int32	Position/angle	RW
607	1	1	Default value force tolerance	Var	int32	Force	RW
608	1	1	Default value force ramp	Var	int32	Force ramp	RW
Drive configuration (➔ Section C.2.11)							
1100	1	1	Cylinder	Var	int32	–	RW
1101	1	1	Cylinder length	Var	int32	Length/swivel angle	RW
1102	1	1	Cylinder diameter	Var	int32	Diameter	RW
1103	1	1	Piston rod diameter	Var	int32	Diameter	RW
1104	1	6	DGCI: Integrated clamping unit	Struct	int32	–	RW
1104	2	6	DGCI: Additional slide	Struct	int32	–	RW
1104	3	6	DGCI: Lubrication function	Struct	int32	–	RW
1104	4	6	DGCI: Slide	Struct	int32	–	RW
1104	5	6	DGCI: Distance between slide and additional slide KR	Struct	int32	Length/swivel angle	RW
1104	6	6	DGCI: Distance between slide and additional slide KL	Struct	int32	Length/swivel angle	RW
1110	1	1	Displacement encoder type	Var	int32	–	RW
1111	1	1	Displacement encoder length	Var	int32	Length/swivel angle	RW
1112	1	1	Displacement encoder serial number	Var	Bit array	–	RW
1120	1	1	Valve	Var	int32	–	RW
1121	1	1	Valve serial number	Var	Bit array	–	RW
1125	1	1	Valve 2	Var	int32	–	RW
1126	1	1	Valve 2 serial number	Var	Bit array	–	RW
Application settings (➔ Section C.2.12)							
1130	1	1	Offset axis zero point	Var	int32	Position/angle	RW
1131	1	1	Homing method	Var	int32	–	RW
1132	1	1	Homing velocity	Var	int32	Speed/ angular velocity	RW
1133	1	1	Homing timeout	Var	int32	Time	RW
1134	1	1	Homing payload	Var	int32	Mass/mass moment of inertia	RW
1140	1	1	Mounting position	Var	int32	Mounting angle	RW
1141	1	1	Supply pressure	Var	int32	Pressure	RW
1142	1	1	Base load	Var	int32	Mass/mass moment of inertia	RW

1) ➔ Tab. C.4

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
1143	1	4	Payload loaded at power on	Var	int32	–	RW
1143	2	4	Dual axis design	Var	int32	–	RW
1143	3	4	Clamping unit present	Var	int32	–	RW
1143	4	4	Through piston rod	Var	int32	–	RW
1144	1	1	Response delay E50	Var	int32	–	RW
Position controller (➔ Section C.2.13)							
1150	1	1	Pos. amplification gain	Var	int32	Controller factor	RW
1151	1	1	Pos. cushioning factor	Var	int32	Controller factor	RW
1152	1	1	Pos. filter factor	Var	int32	Controller factor	RW
1153	1	1	Pos. timeout	Var	int32	Time	RW
1154	1	1	Pos. monitoring time exact stop	Var	int32	Time	RW
1155	1	1	Deactivated standstill control	Var	in32	–	RW
Force controller (➔ Section C.2.14)							
1160	1	1	Force amplification gain	Var	int32	Controller factor	RW
1161	1	1	Force dynamic amplification	Var	int32	Controller factor	RW
1162	1	1	Force filter factor	Var	int32	Controller factor	RW
1163	1	1	Force timeout	Var	int32	Time	RW
1164	1	1	Force monitoring time exact stop	Var	int32	Time	RW
Identification (➔ Section C.2.15)							
1170	1	1	Identification settings	Var	in32	–	RW
1171	1	1	Identification status	Var	Bit array	–	R
1172	X	6	Identified maximum values	Struct	int32	Speed/ angular velocity, acceleration/ angular acceleration	R
1173	1	14	Limiting values: status	Struct	Bit array	–	RW
1173	X	14	Limit values	Struct	int32	➔ Section 3.1.10	R
1174	1	1	Status movement test	Var	Bit array	–	R
1175	1	1	Block adaptation	Var	int32	–	RW
1176	X	16	Offset and hysteresis values of the drive	Array	int32	–	R
System data (➔ Section C.2.16)							
1190	X	43	Hardware actual configuration	Struct	int32/ bit array	–	R
1191	X	15	Analysis data	Array	int32	–	R
1192	1	7	Block download commissioning operation	Struct	int32	–	RW

1) ➔ Tab. C.4

PNU [1]			Name (DE)	Properties [1]			
PNU	Ind.	Max.		Class	Type	Unit	RW
1192	2	7	Configuration status commissioning operation	Struct	int32	–	R
1192	3	7	Commissioning operation. Data reset	Struct	int32	–	RW
1192	4	7	Commissioning operation. Password status	Struct	int32	–	RW
1192	5	7	System of measurement units commissioning operation	Struct	int32	–	RW
1192	6	7	System of units table commissioning operation	Struct	int32	–	R
1192	7	7	Movement test commissioning operation	Struct	int32	–	RW
1193	X	12	System of measurement units	Struct	int32	–	R
1194	X	12	System of measurement units resolution	Struct	int32	–	R
1195	X	5	Start configuration	Struct	int32	–	R
1198	1	1	Trace configuration: maximum supported version	Struct	int32	–	R
1199	X	7	Manufacturing data	Array	int32	–	R
Error texts (➔ Section C.2.17)							
2100 … 2189	X	81	Error texts	Array	Char	–	R

1) ➔ Tab. C.4

Tab. C.5 Overview of CMAX parameters

Representation of the parameter entries

1

Software end position (Limit setpoint position)

Param.	PNU: 501		Index: 1		Max.Index: 2		Class: Var	Data type: int32
2 Values	Linear drive				Semi-rotary drive			
	Unit	Specifi-cation	Minimum	Maximum	Unit	Specifi-cation	Minimum	Maximum
3 Metric	0.01 mm	0	0	1 000 000	0.1°	0	0	100 000
Imperial	0.001 in	0	0	393 701	0.1°	0	0	100 000

4 Permissible range for position setpoint values. Starting with a target position outside of the software end positions is not permissible and will lead to an error or warning. If the software end positions are passed in the running process, the system will issue a warning. The offset to the axis zero point (not to the project zero point!) is specified. Specifying 0 for both software end positions deactivates the software end positions.

Index 1	Lower software end position
Index 2	Upper software end position

The controller checks the software end positions for plausibility and generates an error in case of deviation.

5 ☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

1 Name of the parameter
2 PNU (parameter number) with index, maximum index of the PNU, class and data type
3 Parameter values:
- For integer parameters (int32), the range of values (specification, minimum, maximum) is specified, for integer parameters with physical unit, for each system of measurement units (➔ Appendix B.1, definition of system of units used).
- With bit fields (bit array), the default value is specified bit-wise. It is also specified which bit can assume which value 0, 1 or x (any) during writing. With bit fields the CMAX checks the status of the individual bits, not a value range.
- Strings (char) are specified with their default values and the permissible characters during writing.

4 Description of the parameter, if present for the individual subindices
5 Information about access restrictions and effects on the controller

Fig. C.1 Representation of the parameter entries

C.2.2 Device data

Hardware version of the manufacturer (Manufacturer hardware version)					
Param.	PNU: 100	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0x0100	Minimum: -		Maximum: -	
Coding of the CMAX hardware version. The version number is BCD-encoded; the upper 16 bits are not used. Format: 0x0000HHNN (HH = main version, NN = secondary version)					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Firmware design of the manufacturer (Manufacturer firmware version)					
Param.	PNU: 101	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0x0100	Minimum: -		Maximum: -	
Coding of the CMAX firmware design. The version number is encoded as BCD. Format: 0xPPBBHHNN (PP= patch version, BB = build number/output version, HH = main version, NN = secondary version) Example: 0x037050102 corresponds to the version V2.1.5.37					
Note on compatibility: In firmware design ‹ 2.2, the PNU is coded as follows: Format: 0xBBBBHHNN (BBBB = build number/output version, HH = main version, NN = secondary version). Example: 0x01230102 corresponds to the version V1.2.123					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

FHPP version (Version FHPP)					
Param.	PNU: 102	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0x0110	Minimum: -		Maximum: -	
Coding of the implemented FHPP version. The FHPP version is changed in the event of fundamental adjustments of the FHPP definition. Format: 0x0000HHNN (HH = main version, NN = secondary version)					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Date created (Build date)

Param.	PNU: 103	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	-			
	Permissible characters:	0x00, 0x20...0xFF (zero, printable/expandable ASCII characters)			

Date of creation of the firmware. The date is implemented as a string.
Format “DD.MM.YYYY hh:mm:ss”
Example: 03.07.2008 12:40:44

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Software versions (Software versions)

Param.	PNU: 104	Index: 1 ... 2	Max. Index: 2	Class: Var	Data type: int32
Values	Specification: 0x0100	Minimum: -		Maximum: -	

Software versions of the PlugIn for firmware operation.

Index	Contains
1	Minimal version
2	Recommended version

Format (BCD): 0000HHNN (HH = main version, NN = secondary version)

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Bootloader version (Bootloader version)

Param.	PNU: 105	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0x0100	Minimum: -		Maximum: -	

Version of the bootloader installed.
In the event of a firmware update the bootloader is not overwritten. Prior to a firmware download, the system checks whether the firmware to be written is compatible with the bootloader.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Variant code (Variant code)

Param.	PNU: 107	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0x0001	Minimum: -		Maximum: -	

Labelling for customer-specific variants.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Variant name (Variant name)

Param.	PNU: 108	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	“Standard firmware”			
	Permissible characters:	0x00, 0x20...0xFF (zero, printable/expandable ASCII characters)			
Name or description of a customer-specific firmware variant.					
☒ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

Controller serial number (Controller serial number)

Param.	PNU: 114	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	-			
	Write:	-			
CMAX serial number (CPX module serial number). 8 digits. Example: 37 12 34 56					
☒ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

FCT project identification (FCT project identifier)

Param.	PNU: 116	Index: 1 ... 33	Max. Index: 33	Class: array	Data type: char
Values	Specification:	“0”			
	Permissible characters:	0x30 ... 0x39, 0x41 ... 0x46 (“0” ... “9”, “A” ... “F”)			
	Reset value:	0x00			
UUID (Universally Unique Identifier) for identification of the FCT project. FCT generates a UUID after a project download and writes this into the device as the last parameter. The UUID is saved in the project (not visible). In the CMAX, the UUID is reset to 0 as soon as any parameter in the configuration area (PNUs >= 400) is changed. Changing process and diagnostic data does not cause a reset. The next time the FCT connects with the device, it checks the UUID after the name. If this is identical to the UUID in the project, synchronisation between the device and the project does not need to be carried out.					
☐ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

Manufacturer's device name (Manufacturer device name)

Param.	PNU: 120	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	CPX-CMAX-C1-1			
	Permissible characters:	0x00, 0x20...0x7F (ZERO, printable ASCII characters)			
CMAX designation (type). Characters not used are filled with 0x00 (ZERO).					
☒ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

User's device name (User device name)

Param.	PNU: 121	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	CMAX0001			
	Permissible characters:	0x00, 0x20...0x7F (ZERO, printable ASCII characters)			
	Impermissible characters plug-in:	? @ . , ! : " § | $ % & / \ # ' ' + ~ * ' ; ° ^ ‹ ›			
CMAX designation defined by the user. The name serves identification by FCT and is checked by the FCT when the connection to the device is established. Example: "CMAX1_Slot3". Characters not used are filled with 0x00 (ZERO). The CMAX also contains an axis name (PNU 180 ff) along with the device name.					
☐ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

Manufacturer name (Drive manufacturer)

Param.	PNU: 122	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	Festo AG & Co. KG			
	Permissible characters:	0x00, 0x20...0x7F (ZERO, printable ASCII characters)			
Controller manufacturer's name Characters not used are filled with 0x00 (ZERO).					
☒ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

HTTP address of manufacturer (HTTP drive catalog address)

Param.	PNU: 123	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	www.festo.com			
	Permissible characters:	0x00, 0x20...0x7F (ZERO, printable ASCII characters)			
Internet address of the manufacturer. Characters not used are filled with 0x00 (ZERO).					
☒ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

Festo order number (Festo order number)

Param.	PNU: 124	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	“548932”			
	Permissible characters:	0x00, 0x30...0x39 (ZERO, numerals)			
	Impermissible characters:	-			

Festo order number. This number can be used to order an identical device.
Unused characters are filled with zero (=00h=‘\0’).

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Password (Password)

Param.	PNU: 130	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	“ ” (Blank character string)			
	Permissible characters:	0x00, 0x21...0x7F (ZERO, printable ASCII characters without blanks)			
	Impermissible characters plug-in:	? @ . , ! : “ § | $ % & / \ # ‘ ’ + ~ * ’ ; ° ^ ‹ ›			

Password for operating the CMAX via the PC interface.
On delivery, no password is stored in the device (➔ Section 5.2.1).

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

System password (System password)

Param.	PNU: 133	Index: 1 ... 2	Max. Index: 2	Class: Var	Data type: int32

Internal password for production and system tests.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

System time: number of operating days (System time: count operating days)

Param.	PNU: 140	Index: 1	Max. Index: 2	Class: Struct	Data type: int32
Values	Specification: -	Minimum: -		Maximum: -	

Number of operating days since new status, device data reset or a firmware download.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

System time: milliseconds of the day (System time: milliseconds of the day)					
Param.	PNU: 140	Index: 2	Max. Index: 2	Class: Struct	Data type: int32
Values	Specification: -	Minimum: -		Maximum: -	
Number of milliseconds of the current operating day (PNU 140:01). When switching on, the last value before switching off is loaded.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

The PNU 140 does not contain data of a real-time clock. The number of operating days is counted by the CMAX, saved when switching off and re-loaded when switching on.
1 operating day consists of:
24 * 60 * 60 * 1000 ms = 86 400 000 ms

Language (Language)					
Param.	PNU: 154	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	
Selection of the language in the specific parameter values, etc., transferred by the CMAX, e.g. the error texts in PNU 2100 to 2189.					
Value	**Language**				
0	English				
1	German				
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Supported languages (Supported languages)									
Param.	PNU: 155	Index: 1		Max. Index: 1		Class: Var		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	0011
	Write:	-							
Reading of the supported languages for transfer of specific parameter values.									
Bit	**Language**								
0	English								
1	German								
2	Spanish								
3	French								
4	Italian								
5 ... 32	Reserved for expansion								
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.									

Axis name (Axis name)

Param.	PNU: 180	Index: 1 ... 30	Max. Index: 30	Class: array	Data type: char
Values	Specification:	Axis X			
	Permissible characters:	0x00, 0x20...0xFF (ZERO, printable/expandable ASCII characters)			
	Impermissible characters plug-in:	‹ › \ DEL (0x3C, 0x3E, 0x5C, 0x7F)			
Name of the axis / the drive on the axis interface X.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

C.2.3 Diagnostics

The diagnostic memory and diagnostic parameters are described in detail in the sections 4.3 and 4.3.

Diagnostic event (Diagnostic event)					
Param.	PNU: 200	Index: 1 ... 100	Max. Index: 100	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Type of diagnostic message (➔ Section 4.3.2). Not only errors and warnings are entered into the diagnostic memory of the CMAX, but also switch-on operations, resets or configuration events. The interpretation of the diagnostic code and the additional information depends on the type of these events.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Diagnostic code (Diagnostic code)					
Param.	PNU: 201	Index: 1 ... 100	Max. Index: 100	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
The diagnostic code includes detail on the diagnostic event. For errors and warnings, this is the exact number, for configuration events the function performed, etc. ➔ Section 4.3.2.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Time stamp time of day (Time stamp: time of day)					
Param.	PNU: 202	Index: 1 ... 100	Max. Index: 100	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Time of the current operating day in milliseconds at the time of the message. This timestamp is not a real-time clock: The time is read from the device data PNU 140:02 when the message occurs.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Additional information (Additional information)

Param.	PNU: 203	Index: 1 ... 100	Max. Index: 100	Class: array	Data type: bit array
Values	Specification:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

The parameter includes detailed information about the diagnostic event / entry in the diagnostic memory. This information mainly serves to make diagnostics convenient using the FCT. The evaluation is complex and therefore not suitable for a controller program. Description (➔ Section 4.3).

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Reserved (Reserved)

Param.	PNU: 204	Index: 1	Max. Index: 5	Class: Struct	Data type: int32
Values	Specification: 1	Minimum: -		Maximum: -	

Reserved. Not used by the CMAX.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Reserved (Reserved)

Param.	PNU: 204	Index: 2	Max. Index: 5	Class: Struct	Data type: int32
Values	Specification: 2	Minimum: -		Maximum: -	

Reserved. Not used by the CMAX.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Clear memory (Clear memory)

Param.	PNU: 204	Index: 3	Max. Index: 5	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

Writing of 1: The entire diagnostic memory is deleted. Reading always delivers the value 0.
Deleting is usually not required, since the memory is organised as a ring buffer. If the memory is full, the new entry overwrites the oldest.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Number of entries (Number of entries)

Param.	PNU: 204	Index: 4	Max. Index: 5	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Number of assigned entries in the diagnostic memory.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Number of unread entries (Number of unread entries)

Param.	PNU: 204	Index: 5	Max. Index: 5	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Number of new entries since switching on. FCT deletes the value after reading the diagnostic messages. Every new entry increments the value. This parameter can be written by FCT without password and master control.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Active errors (Current errors)

Param.	PNU: 220	Index: 1 ... 3	Max. Index: 3	Class: array	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			

Active error messages. Each parameter is a bit field consisting of three uint32 values and thus contains 3x 32 bits = 96 bits of memory capacity. Each bit in this array represents a fault number. If it is set, the corresponding error message is active.

Example:

PNU 220:01 = 0x00000001	Bit 0 set	E01 active
PNU 220:02 = 0x00000040	Bit 38 (32+ 6) set	E39 active
PNU 220:03 = 0x00030000	Bit 80 (32 + 32 + 16) set	E81 active
	Bit 81 (32 + 32 + 17) set	E82 active

This representation is designed for evaluation by a higher-order controller. Bit coding can be used directly to approach an MMI. Error numbers ➔ Section 4.2.4.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Active warnings (Current warnings)

Param.	PNU: 221	Index: 1 ... 3	Max. Index: 3	Class: array	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			

Active warning messages, see active error messages PNU 220. The distinction allows the higher-order controller to respond to errors and warnings specifically.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Time stamp: day of operation (Time stamp: day of operation)

Param.	PNU: 222	Index: 1 ... 100	Max. Index: 100	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

Current day of operation (since new status, device data reset or a firmware download) when the message occurs.
This timestamp is not a real-time clock: The time is read from the device data PNU 140:01 when the message occurs.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Currently shown error on the display (Current error on display)

Param.	PNU: 224	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

Error number that is currently shown on the display. This makes synchronisation between the display in the FCT and the CMAX possible. The error occurring first is always displayed.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Active fault level (Current error level)

Param.	PNU: 225	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

With this, FCT can display the current status of the CMAX corresponding to section 4.2.1. The most serious currently reported event is always responsible for the current level.

Value	Level	Meaning
0	–	–
2	W	Warning
5	F1	Fault 1
6	F2	Fault 2
15	FS	System fault

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Current warning to be displayed in FCT (Current warning to display in FCT)

Param.	PNU: 226	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

The PNU 226 contains the warning number the FCT is supposed to display. Warnings are not displayed on the CMAX display.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Error status for FCT (Error status for FCT)

Param.	PNU: 227	Index: 1 ... 89	Max. Index: 89	Class: array	Data type: bit array
Values	Specification:	0000 0000 0000 0000 0000 0000 0000 0000			
	Write:	-			

The bit-coded error status makes it possible to indicate the exact status of a message. The coding is identical to the coding of the additional information in PNU 203. Description ➔ Section 4.3.3.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Diagnostic events filter (Filter diagnostic events)

Param.	PNU: 228	Index: 1		Max. Index: 3		Class: Struct		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	1111
	Write:	0000	0000	0000	0000	0000	0000	0000	xxxx

This setting can be used to define the scope of the records. By default, the CMAX records very large quantities of information. Not all of it is equally important. Certain information can be deliberately excluded from recording. In this way, only the most important events are included in the diagnostic memory. Assignment ➔ Section 4.4.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Errors and warnings filter (Filter errors ans warnings)

Param.	PNU: 228	Index: 2		Max. Index: 3		Class: Struct		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0111	1111
	Write:	0000	0000	0000	0000	0000	0000	0xxx	xxxx

The filter allows certain errors and warnings to be excluded from the diagnostic memory records. This makes sense for messages that are part of the normal operating cycle because they are inherent to the process (load voltage errors) or because they occur frequently for other reasons. Assignment ➔ Section 4.4.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Error characteristics setting (Error behaviour configuration)

Param.	PNU: 228	Index: 3		Max. Index: 3		Class: Struct		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	1100	0000
	Write:	0000	0000	0000	0000	0000	000x	xxxx	xxxx

Some errors can also be reported as warnings. This concerns in particular function monitoring, such as maintaining the software end position. Often the right correct reaction depends on the application in these cases. Assignment ➔ Section 4.4.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

C.2.4 Process data

Position values (Position values)

Param.	PNU: 300		Index: 1 ... 3	Max. Index: 3	Class: array		Data type: int32	
Values	Linear drive				Semi-rotary drive			
	Unit	Specifi-cation	Minimum	Maximum	Unit	Specifi-cation	Minimum	Maximum
Metric	0.01 mm	-	-1 000 000	1 000 000	0.1 °	-	-100 000	100 000
Imperial	0.001 in	-	-393 701	393 701	0.1 °	-	-100 000	100 000

Index	**Value**
1	Current actual position of the controller
2	Current setpoint position of the controller
3	Current deviation

When force control is active, the current setpoint position is tracked to the actual position.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Force values (Force values)

Param.	PNU: 301		Index: 1 ... 3	Max. Index: 3	Class: array		Data type: int32	
Values	Linear drive				Semi-rotary drive			
	Unit	Specifi-cation	Minimum	Maximum	Unit	Specifi-cation	Minimum	Maximum
Metric	1 N	-	-1 000 000	1 000 000	1 Nm	-	-1000000	1 000 000
Imperial	1 lbf	-	-224 809	224 809	1 lbf ft	-	-737 561	737 561

Index	**Value**
1	Current actual force of the controller
2	Current setpoint force of the controller
3	Current deviation

When position control is active, the current setpoint force = 0.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Pressure values (Pressure values)

Param.	PNU: 302		Index: 1 ... 3		Max. Index: 3		Class: array		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specifi-cation	Minimum	Maximum	Unit	Specifi-cation	Minimum	Maximum		
Metric	0.1 bar	-	-120	120	0.1 bar	-	-120	120		
Imperial	1 psi	-	-174	174	1 psi	-	-174	174		

Index	Value
1	Pressure valve chamber 1
2	Pressure valve chamber 2
3	Reserved

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Number of positioning commands (Count of positioning commands)

Param.	PNU: 305	Index: 1	Max. Index: 4	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2 147 483 647	

Sum of all executed start commands of the position controller.
Jogging, homing or identifications are not counted.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Number of force commands (Count of force commands)

Param.	PNU: 305	Index: 2	Max. Index: 4	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2 147 483 647	

Sum of all executed start commands of the force controller.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Sum of stroke lengths (Cumulated stroke length)

Param.	PNU: 305	Index: 3	Max. Index: 4	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2 147 483 647	

Sum of the movements of the drive since the new status, last data reset or firmware download.
Records all the movements performed by the drive, irrespective of control mode or enable.
Attention: Specification is always in metres, independent of the system of measurement units established.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Sum of stroke lengths fraction (Cumulated stroke length fraction)

Param.	PNU: 305	Index: 4	Max. Index: 4	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1 000 000	

Sum of the movements of the drive since the last full metre was reached (PNU 305:03). Records all the movements performed by the drive, irrespective of control mode or enable.
Attention: Specification is always in micrometres, independent of the system of measurement units established.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Current speed (Current velocity)

Param.	PNU: 307		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	-	-10 000 000	10 000 000	1 °/s	-	-10 000 000	10 000 000
Imperial	0.01 ft/s	-	-3 280 840	3 280 840	1 °/s	-	-10 000 000	10 000 000

Calculated actual speed.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Extended axis status (Additional axis status)

Param.	PNU: 308	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	-			
	Write:	-			

Additional status information of the controller.
These are also valid in parameterisation mode if SPOS is not available.

Bit	Status information	Status bit
0	Referenced	SPOS.REF
1	Motion Complete	SPOS.MC
2	Drive in motion	SPOS.MOV
3	Following error/tolerance error	SPOS.DEV
4	In tolerance	–
5	Standstill warning	SPOS.STILL
6	Supply pressure in tolerance	–
7 ... 11	Reserved	–
12	Position control is active	–
13	Standstill control is active	–
14	Force control is active	–
15, 16	Reserved	–

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Valve setpoint specification (Valve output value)

Param.	PNU: 309	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 2047	Minimum: 0		Maximum: 4095	

Internal setpoint specification for the valve

Value	Standardised value	Pressurisation	Exhaust	Drive travels
4095	-100 %	1 --› 4	2 --› 3	... in the direction of smaller actual values
2047	0 %	Closed	closed	... not at all
0	100 %	1 --› 2	4 --› 5	... in the direction of greater actual values

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

C.2.5 Record table

Information on structure of the record table ➔ Section 3.3.2.

Setpoint record number (Requested record no)

Param.	PNU: 400	Index: 1	Max. Index: 3	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 64	

The record number that was accepted with the last starting edge.
If no record was started yet, the value will be 0 (no permissible record number).

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Actual record number (Actual record no)

Param.	PNU: 400	Index: 2	Max. Index: 3	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 64	

The number of the record executed last.
If no record was executed yet, the value will be 0. This is no permissible record number.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Record status byte (Record status byte)

Param.	PNU: 400	Index: 3	Max. Index: 3	Class: Struct	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			

Record status byte (RSB): includes a feedback code that is transferred to the input data.
According to FHPP, only bits 0 ... 7 are defined. Bits 8 ... 31 are always 0. Description of the bits ➔ Section 2.2.3.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Record control byte 1 (Record control byte 1)

Param.	PNU: 401	Index: 1 ... 64	Max. Index: 64	Class: array	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	0000 0000	0000 0000	0000 0000	0xxx 0xxx

The record control byte 1 (RCB1) controls the most important settings for the movement command. It corresponds to the CDIR in direct mode (➔ Section 2.2.4).

Bit	Name	Description
0 (REL)	Setpoint value relative	= 0: Setpoint value is absolute (for position control, with respect to the project zero point)
		= 1: Setpoint value is relative to the last setpoint/actual value[1)]
1 (COM1)	Control mode 1	= 0: Position control
		= 1: Force control
2 (COM2)	Control mode 2	For position control only (COM1=0):
		= 0: Free profile: Speed and acceleration are freely specified
		= 1: Automatic profile speed and acceleration are specified by the controller[2)]
3	–	Reserved, must be 0
4	Speed monitoring deactivated	For force control:
		= 0: Activate speed limit
		= 1: Deactivate speed limit
5	Stroke monitoring deactivated	For force control:
		= 0: Activate stroke monitoring
		= 1: Deactivate stroke monitoring
6	Fast stop	Regulation for setting MC upon reaching target value (quality class ➔ Section 3.1.6)[3)]
		= 0: Exact stop
		= 1: Fast stop
7 ... 32	–	Reserved, must be 0

1) Position control: Setpoint value is relative to the last setpoint value (with MC) or to the actual value (if MC is not present). Force control ➔ Section 3.1.2.

2) Speed and acceleration are chosen by the controller as appropriate to the identification so that the target position is reached as quickly as possible and without overswing.

3) SPOS.MC is only set when the movement command corresponding to the selected regulation is completed. In the event of a fast stop, the standstill monitoring is deactivated.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Record control byte 2 (Record control byte 2)

Param.	PNU: 402	Index: 1 ... 64		Max. Index: 64		Class: array		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	0000
	Write:	0000	0000	0000	0000	0000	0000	xxxx	xxxx

Record control byte 2 (RCB2) controls conditional record chaining.

Bit	Description
0 ... 6	= Sequencing condition for automatic record chaining (decimal value): 0: no step enabling condition; 2: position; 3: force; 4: standstill; 5: time; 11: stroke; 12: MC; 13: stroke after force; 14: position with force
7	= 1: Disable record sequencing, in case a condition was defined. (only for debugging purposes, not for normal control purposes).

Values not stated are impermissible. Description ➔ Section 3.3.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Record default values (Record defaults)

Param.	PNU: 403	Index: 1 ... 64		Max. Index: 64		Class: array		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	0000
	Write:	xx00	0000	0000	0000	000x	xxxx	xxxx	xxxx

The parameter controls blocking of the record and acceptance of the default values.

Bit	Description
0 ... 12	= 0: used value in the record parameter PNU 406 ff
	= 1: used global default values corresponding to PNU 600 ... 612
	Information on the global default values ➔ Section 5.3.
30	= 0: Record is not initialised or deleted
	= 1: Record initialised by user
	Records not initialised can contain data, but are not executed. FCT indicates these records as blank records (no upload/download or deviation during synchronisation)
31	= 0: Record blocked (inactive)
	= 1: Record enabled (active)
	Blocked or inactive records are not executed.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Setpoint value record (Record setpoint value)					
Param.	PNU: 404	Index: 1 ... 64	Max. Index: 64	Class: array	Data type: int32
Values	Specification: 0	Minimum: -1 000 000		Maximum: 1 000 000	
Control mode position (RCB1.COM1 = 0):		Position setpoint value in unit position (index 1)			
Control mode force (RCB1.COM1 = 1):		Force setpoint value in unit force (index 3)			
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Record preselected value (Record preselection value)					
Param.	PNU: 405	Index: 1 ... 64	Max. Index: 64	Class: array	Data type: int32
Values	Specification: 0	Minimum: -1 000 000		Maximum: 1 000 000	
Contains the value at which sequencing occurs. The meaning depends on the condition in RCB2 (PNU 402):					
Step criterion		**Physical variable (➔ Appendix B.1)**			
2	Position	Position/angle			
3	Force	Force			
4	Standstill	Time			
5	Time	Time			
11	Stroke	Position/angle			
12	MC	Time			
13	Stroke after force	Position			
14	Position at force	Position			
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Speed record (Record velocity)

Param.	PNU: 406		Index: 1 ... 64		Max. Index: 64		Class: array		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.001 m/s	0	0	10 000	1 °/s	0	0	10 000		
Imperial	0.01 ft/s	0	0	3 281	1 °/s	0	0	10 000		

Speed setpoint value, depends on the control mode and travel profile (PNU 401):

Control mode position, free profile:

Maximum speed at which the drive is to be moved. Depending on the setpoint stroke and the parameterised accelerations, this speed may not be reached.

Control mode position, automatic profile:

Parameter is ignored. The maximum speed is derived from the movement profile determined during identification.

Control mode force:

Maximum speed at which the drive travels. If the actual speed reaches this value, the force control switches to positioning and continues at this speed until it arrives at the workpiece and the speed reduces or the setpoint force is reached. The speed 0 deactivates the switchover to position control (➔ Section 3.1.2).

Presetting:	
For position control:	PNU 403, bit 0 = 0: global default value from parameter PNU 600
For force control:	PNU 403, bit 1 = 0: global default value from parameter PNU 601

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Acceleration record (Record acceleration)

Param.	PNU: 407		Index: 1 ... 64		Max. Index: 64		Class: array	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s²	0	0	100 000	1 °/s²	0	0	100 000
Imperial	0.01 ft/s²	0	0	32 808	1 °/s²	0	0	100 000

Acceleration setpoint value for starting up, depending on the control mode and travel profile (PNU 401):

Control mode position, free profile:

Setpoint acceleration of the controller. If dynamic identification was performed, this value is reduced to a value that can be reached by the drive.

Control mode position, automatic profile:

This parameter is ignored. The acceleration is derived from the movement profile determined during identification.

Control mode force:

This parameter is ignored.

Presetting:

For position control:	PNU 403, bit 2 = 0: global default value from parameter PNU 602
For force control:	–

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Deceleration record (Record decelaration)

Param.	PNU: 408		Index: 1 ... 64		Max. Index: 64		Class: array	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s^2	0	0	100 000	1 $°/s^2$	0	0	100 000
Imperial	0.01 ft/s^2	0	0	32 808	1 $°/s^2$	0	0	100 000

Deceleration setpoint value for braking, depending on the control mode and travel profile (PNU 401):

Control mode position, free profile:

Setpoint deceleration of the controller for axis braking. If dynamic identification was performed, this value is reduced to a value that can be reached by the drive.

Control mode position, automatic profile:

This parameter is ignored. The deceleration is derived from the movement profile determined during identification.

Control mode force:

This parameter is ignored.

Presetting:

For position control:	PNU 403, bit 3 = 0: global default value from parameter PNU 603
For force control:	–

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Payload record (Record payload)

Param.	PNU: 410		Index: 1 ... 64		Max. Index: 64		Class: array	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.1 kg	0	0	200 000	1 kg cm^2	0	0	20 000
Imperial	1 lb	0	0	44 093	0.1 lb in^2	0	0	68 343

Current payload.

Deviations from the actual mass load worsen the positioning behaviour. With changes of the mass load of approx. 30 % or more, the current payload should be specified. The total moving mass is the sum of base load (PNU 1142) and payload.

For vertical installation, the correct payload is absolutely essential in order to calculate the zero force of the force control. An error in the specification can lead to a movement of the axis if the setpoint value is 0 N.

Presetting:

For position control:	PNU 403, bit 5 = 0: global default value from parameter PNU 605
For force control:	PNU 403, bit 5 = 0: global default value from parameter PNU 605

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Tolerance record (Record tolerance)

Param.	PNU: 411		Index: 1 ... 64		Max. Index: 64		Class: array		Data type: int32	
Values	Linear drive position control				Semi-rotary drive position control					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.01 mm	0	0	1 000	0.1 °	0	0	100		
Imperial	0.001 in	0	0	394	0.1 °	0	0	100		
	Linear drive force control				Semi-rotary drive force control					
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.					
Metric	1 N	0	0	1 000						
Imperial	1 lbf	0	0	225						
Specification of the tolerance to be used with this record.										
Control mode position (RCB1.COM1 = 0)					Position tolerance in unit position (index 1)					
Control mode position (RCB1.COM1 = 1)					Force tolerance in unit force (index 3)					
Presetting:										
For position control:	PNU 403, bit 6 = 0: global default value from parameter PNU 606									
For force control:	PNU 403, bit 7 = 0: global default value from parameter PNU 607									
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.										

Force ramp record (Record force ramp)

Param.	PNU: 412		Index: 1		Max. Index: 64		Class: array		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.					
Metric	1 N/s	0	0	100 000						
Imperial	1 lbf/s	0	0	22 481						
The force ramp permits setting the increasing speed of the force. The controller generates a $\sin^2$-shaped rise in the setpoint force for optimising the control behaviour (➔ Section 3.1.2).										
Presetting:										
For position control:	–									
For force control:	PNU 403, bit 8 = 0: global default value from parameter PNU 608									
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.										

C.2.6 Project Data

General description of the measuring reference system (➔ Appendix B.2).

Offset project zero point (Offset project zero point)

Param.	PNU: 500		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.01 mm	0	-1 000 000	1 000 000	0.1 °	0	-100 000	100 000		
Imperial	0.001 in	0	-393 701	393 701	0.1 °	0	-100 000	100 000		

Reference point for position values in the application (➔ Appendix B.2).

☐ The parameter value cannot be changed.

☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.

☒ After writing, controller recalculation is carried out.

Software end position (Limit setpoint position)

Param.	PNU: 501		Index: 1 ... 2		Max. Index: 2		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.01 mm	0	0	1 000 000	0.1 °	0	0	100 000		
Imperial	0.001 in	0	0	393 701	0.1 °	0	0	100 000		

Permissible range for position setpoint values. Starting with a target position outside of the software end positions is not permissible and will lead to an error or warning. If the software end positions are passed in the running process, the system will issue a warning. The offset to the axis zero point (not to the project zero point!) is specified. Specifying 0 for both software end positions deactivates the software end positions.

Index 1:	Lower software end position
Index 2:	Upper software end position

The controller checks the software end positions for plausibility and generates an error in case of deviation. Notes on calculation of the software end positions and a sample calculation for the maximum values ➔ Appendix B.2.4.

☐ The parameter value cannot be changed.

☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.

☒ After writing, controller recalculation is carried out.

Stop deceleration (Stop deceleration)

Param.	PNU: 507		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s²	10 000	10	100 000	1 °/s²	10 000	10	100 000
Imperial	0.01 ft/s²	3 000	3	32 808	1 °/s²	10 000	10	100 000

Deceleration in the event of stop or error. Deceleration of the stop ramp to be executed is he maximum of:

– stop ramp deceleration PNU 507
– Setpoint deceleration in the last movement command PNU 408

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Critical stroke with force control (Critical stroke during force control)

Param.	PNU: 510		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01 mm	5 000	100	1 000 000	0.1 °	100	10	100 000
Imperial	0.001 in	2 000	39	393 701	0.1 °	100	10	100 000

Maximum permitted stroke with active force control.
With active force control, the actual position relative to the start position must not change by more than the amount specified in this parameter. In this way, you can ensure that the axis will not perform an uncontrolled movement if force control is activated by mistake (“Workpiece missing”, for example).
Monitoring can be deactivated by setting the bits RCB1.XLIM or CDIR.XLIM

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Min. permitted force setpoint value (Lower limit setpoint force)

Param.	PNU: 511		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 N	0	-100 000	0		
Imperial	1 lbf	0	-22 481	0		

Smallest permitted setpoint value for force control. A smaller setpoint value results in an error or warning.
If both the smallest (PNU 511) and the largest (PNU 512) permissible force setpoint value are set to zero, the setpoint limits are ignored when executing a force command

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Max. permitted force setpoint value (Upper limit setpoint force)

Param.	PNU: 512	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive			Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.
Metric	1 N	0	0	100 000	
Imperial	1 lbf	0	0	22 481	

Largest permitted setpoint value for force control. A larger setpoint value results in an error or warning.
If both the smallest (PNU 511) and the largest (PNU 512) permissible force setpoint value are set to zero, the setpoint limits are ignored when executing a force command.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Critical speed with force control (Critical velocity during force control)

Param.	PNU: 514	Index: 1	Max. Index: 1	Class: Var	Data type: int32			
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	200	10	500	1 °/s	200	10	500
Imperial	0.01 ft/s	65	3	164	1 °/s	200	10	500

Max. permitted speed after start of a force command. This parameter is used for monitoring, not to limit the speed. If the actual speed exceeds the set value, an error is reported, the axis stops and the force command is cancelled.
The speed limit value must be significantly larger than the speed limit of the PNU 406/554, otherwise monitoring will lead to an error when the speed limit is reached. The speed limit value should preferably be used as security when speed limiting PNU 406/554 was deactivated.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Jog mode default values (Jog mode defaults)

Param.	PNU: 521	Index: 1		Max. Index: 4		Class: array		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	1101
	Write:	0000	0000	0000	0000	0000	000x	xxxx	xxxx

This parameter determines the use of the default values for jogging.
A set bit means that, instead of the global setpoint values (PNU 6xx), the jog parameters (PNU 53x) are used ➔ Section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Position default values (Direct mode position defaults)

Param.	PNU: 521	Index: 2		Max. Index: 4		Class: array		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	0000
	Write:	0000	0000	0000	0000	0000	000x	xxxx	xxxx

This parameter determines the use of the default values for the positioning command in the direct mode.

A set bit means that, instead of the global setpoint values (PNU 6xx), the jog parameters for position direct mode (PNU 54x) are used ➔ Section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Force default values (Direct mode force defaults)

Param.	PNU: 521	Index: 3		Max. Index: 4		Class: array		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	0000
	Write:	0000	0000	0000	0000	0000	000x	xxxx	xxxx

This parameter determines the use of the default values for the positioning command in the direct mode.

A set bit means that, instead of the global setpoint values (PNU 6xx), the parameters for force direct mode (PNU 55x) are used ➔ Section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Homing default values (Direct mode homing defaults)

Param.	PNU: 521	Index: 4		Max. Index: 4		Class: array		Data type: bit array	
Values	Specification:	0000	0000	0000	0000	0000	0000	0000	0000
	Write:	0000	0000	0000	0000	0000	000x	000x	0000

This parameter determines use of the default value for the payload in homing.

A set bit means that, instead of the global default value (PNU 605), the parameter for homing (PNU 1134) is used ➔ Section 5.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Reserved (Reserved)					
Param.	PNU: 522	Index: 1	Max. Index: 2	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 0	
Reserved.					
☐ The parameter value cannot be changed.					
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

FHPP: Control/status bits: level CCON.BRAKE (FHPP: Control-/Statusbits: CCON.BRAKE level)					
Param.	PNU: 522	Index: 2	Max. Index: 2	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	
Effect of clamping unit/brake.					
Value	**Function**				
0	Clamping unit/brake opens (switching output at the valve at 24 V) with CCON.BRAKE = 1				
1	Clamping unit/brake opens (switching output at the valve at 24 V) with CCON.BRAKE = 0				
☐ The parameter value cannot be changed.					
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

FHPP: Setpoint and actual values (FHPP: Setpoint and actual values)

Param.	PNU: 523	Index: 1	Max. Index: 8	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2	

Determination of the setpoint and actual values in the cyclical I/O data for the various controller modes ➔ Section 2.2. Presetting for each index is the value 0.
Note: The setpoint values have no effect on the commissioning operations jogging and homing.

Index	Setpoint/actual value	Operating mode	Value	The setpoint/actual value is accepted
Position control				
1	Secondary setpoint value	Direct mode	= 0:	Speed as a percentage of PNU 540/600
			= 1:	Payload as a percentage of PNU 544/605
2	Primary setpoint value	Direct mode	= 0:	Setpoint position/angle in the system of measurement units ➔ B.1
3	Secondary actual value[1]	Record mode	= 0:	Record status byte PNU 400:03
		Direct mode		Speed as a percentage of PNU 540/600
		Commissioning		Progress in percentage/teaching goal
		Record mode, direct mode, commissioning	= 1:	Current error number[4]
4	Primary actual value[2]	Record mode, direct mode, commissioning	= 0:	Actual position/angle in the system of measurement units
			= 1:	Actual force in the system of measurement units[3]
			= 2:	Actual force/actual position scaled[3][4][5]
Force control[3]				
5	Secondary setpoint value	Direct mode	= 0:	Force ramp in percentage of PNU 550/608
			= 1:	Payload as a percentage of PNU 551/605
6	Primary setpoint value	Direct mode	= 0:	Setpoint force in system of units ➔ B.1
7	Secondary actual value[1]	Record mode	= 0:	Record status byte PNU 400:03
		Direct mode		Speed as a percentage of PNU 540/600
		Commissioning		Progress in percentage/teaching goal
		Record mode, direct mode, commissioning	= 1:	Current error number[4]
8	Primary actual value[2]	Record mode, direct mode, commissioning	= 0:	Actual position in the system of measurement units
			= 1:	Actual force in the system of measurement units
			= 2:	Actual force/actual position scaled[4][5]

1) Secondary actual value must be configured identically for force and positioning control (i.e. both 0 or 1).
2) Main actual value "Current force/current position scaled" (value = 2) must be configured identically for force and positioning control.
3) Force/torque values are not supported for semi-rotary drives and must not be parameterised.
4) Only available from FW 2.2 or higher
5) Resolution is adjusted depending on the cylinder diameter -➔ Section 2.2.3, Tab. 2.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

C.2.7 Jog mode

Jog mode, creeping speed (Jog mode slow velocity)

Param.	PNU: 530		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	50	10	500	1 °/s	50	10	500
Imperial	0.01 ft/s	15	3	164	1 °/s	50	10	500

Slow speed for jogging.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Jog mode, maximum speed (Jog mode fast velocity)

Param.	PNU: 531		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	200	10	10 000	1 °/s	200	10	10 000
Imperial	0.01 ft/s	65	3	3 281	1 °/s	200	10	10 000

Maximum speed after expiration of the jogging slow speed period.
Only effective if use of the global default value (default value for speed, position control, PNU 600) has been deactivated with PNU 521:01.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Jog mode acceleration (Jog mode acceleration)

Param.	PNU: 532		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s^2	100	10	100 000	1 °/s^2	100	10	100 000
Imperial	0.01 ft/s^2	30	3	32 808	1 °/s^2	100	10	100 000

Jogging acceleration.
Only effective if use of the global default value (default value for acceleration, PNU 602) has been deactivated with PNU 521:01.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Jog mode deceleration (Jog mode decelaration)

Param.	PNU: 533		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s²	500	10	100 000	1 °/s²	500	10	100 000
Imperial	0.01 ft/s²	150	3	32 808	1 °/s²	500	10	100 000

Jogging deceleration.
Only effective if use of the global default value (default value for deceleration, PNU 603) has been deactivated with PNU 521:01.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Jog mode creeping period (Jog mode crawling time)

Param.	PNU: 534		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	1 ms	3 000	0	1 000 000	1 ms	3 000	0	1 000 000
Imperial	1 ms	3 000	0	1 000 000	1 ms	3 000	0	1 000 000

Duration of the creeping phase.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Jog mode payload (Jog mode payload)

Param.	PNU: 536		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.1 kg	0	0	200 000	1 kg cm²	0	0	20 000
Imperial	1 lb	0	0	44 093	0.1 lb in²	0	0	68 343

Payload during jogging.
Only effective if use of the global default value (default value for payload, PNU 605) has been deactivated with PNU 521:01.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

C.2.8 Direct mode position control

Direct mode position speed (Direct mode position velocity)

Param.	PNU: 540		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	2 000	10	10 000	1 °/s	1 000	10	10 000
Imperial	0.01 ft/s	650	3	3 281	1 °/s	1 000	10	10 000

Base value of speed in position control direct mode.
The controller transmits a percentage value in the output data, which is multiplied by the base value to determine the final setpoint speed.
In case of continuous setpoint specification (tracking mode), the setpoint values are calculated internally ➔ Section 3.4.2.
Only effective if use of the global default value (default value for speed, position control, PNU 600) has been deactivated with PNU 521:02.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Direct mode position acceleration (Direct mode position acceleration)

Param.	PNU: 541		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s^2	2 000	10	100 000	1 °/s^2	1 000	10	100 000
Imperial	0.01 ft/s^2	650	3	32 808	1 °/s^2	1 000	10	100 000

Acceleration in position control direct mode ➔ Section 3.4.
In case of continuous setpoint specification (tracking mode), the setpoint values are calculated internally ➔ Section 3.4.2.
Only effective if use of the global default value (default value for acceleration, PNU 602) has been deactivated with PNU 521:02.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Direct mode position deceleration (Direct mode position decelaration)

Param.	PNU: 542		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specifi-cation	Minimum	Maximum	Unit		Specifi-cation	Minimum	Maximum	
Metric	0.001 m/s²	2 000	10	100 000	1 °/s²		1 000	10	100 000	
Imperial	0.01 ft/s²	650	3	32 808	1 °/s²		1 000	10	100 000	

Deceleration in position control direct mode ➔ Section 3.4.
PNU 542 does not use continuous setpoint specification (tracking mode) ➔ Section 3.4.2.
Only effective if use of the global default value (default value for deceleration, PNU 603) has been deactivated with PNU 521:02.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Direct mode payload position (Direct mode position payload)

Param.	PNU: 544		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specifi-cation	Minimum	Maximum	Unit		Specifi-cation	Minimum	Maximum	
Metric	0.1 kg	0	0	200 000	1 kg cm²		0	0	20 000	
Imperial	1 lb	0	0	44 093	0.1 lb in²		0	0	68 343	

Payload in direct mode position control.
Only effective if use of the global default value (default value for payload, PNU 605) has been deactivated with PNU 521:02.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Direct mode position tolerance (Direct mode position tolerance)

Param.	PNU: 545		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specifi-cation	Minimum	Maximum	Unit		Specifi-cation	Minimum	Maximum	
Metric	0.01 mm	100	10	1 000	0.1 °		10	1	100	
Imperial	0.001 in	40	4	394	0.1 °		10	1	100	

Tolerance in position control direct mode.
Only effective if use of the global default value (default value position tolerance PNU 606) has been deactivated with PNU 521:02.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

C.2.9 Force control in direct mode

Direct mode force force ramp (Direct mode force value force ramp)

Param.	PNU: 550		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 N/s	1 000	10	100 000		
Imperial	1 lbf/s	200	2	22 481		

Base value for the force ramp in direct mode. The controller transmits a percentage value in the output data, which is multiplied by the base value to determine the final setpoint ramp.
Only effective if use of the global default value (default value for force ramp, PNU 608) has been deactivated with PNU 521:03.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Direct mode force payload (Direct mode force payload)

Param.	PNU: 551		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	0.1 kg	0	0	200 000		
Imperial	1 lb	0	0	44 093		

Payload in force control direct mode.
Only effective if use of the global default value (default value for payload, PNU 605) has been deactivated with PNU 521:03.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Direct mode force force tolerance (Direct mode force tolerance force)

Param.	PNU: 552		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 N	10	1	1 000		
Imperial	1 lbf	3	1	225		

Tolerance window in force control direct mode.
Only effective if use of the global default value (default value force tolerance PNU 607) has been deactivated with PNU 521:03.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Direct mode force speed limit (Direct mode force velocity limit)

Param.	PNU: 554		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	0.001 m/s	50	0	500		
Imperial	0.01 ft/s	15	0	164		

Maximum speed at which the drive travels. If the actual speed exceeds this value, the force control switches to positioning and continues at this speed until it arrives at the workpiece, standstill is recognised or the setpoint force is reached. Specification of 0 deactivates the switchover to position control (➔ Section 3.1.2).
Only effective if use of the global default value (default value for speed, position control, PNU 601) has been deactivated with PNU 521:03.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

C.2.10 Global default values

Default value speed position control (Default value velocity position mode)

Param.	PNU: 600		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	2 000	10	10 000	1 °/s	1 000	10	10 000
Imperial	0.01 ft/s	650	3	3 281	1 °/s	1 000	10	10 000

This value contains the globally preset speed. This is used in all movement commands with position control where no individual speed is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 0 (= 00000001h)

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Default value speed limit force control (Default value velocity limit force mode)

Param.	PNU: 601		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	0.001 m/s	50	0	500		
Imperial	0.01 ft/s	15	0	164		

This value contains the globally preset speed. This is used in all movement commands with force control where no individual speed is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 1 (= 0000 0002h)

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Default value acceleration (Default value acceleration)

Param.	PNU: 602		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s^2	2 000	10	100 000	1 °/s^2	1 000	10	100 000
Imperial	0.01 ft/s^2	650	3	32 808	1 °/s^2	1 000	10	100 000

This value contains the globally preset acceleration. This is used in all movement commands with position control where no individual acceleration is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 2 (=0000 0004h)

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Default value deceleration (Default value decelaration)

Param.	PNU: 603		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.001 m/s²	2 000	10	100 000	1 °/s²	1000	10	100 000		
Imperial	0.01 ft/s²	650	3	32 808	1 °/s²	1000	10	100 000		

This value contains the globally preset deceleration. This is used in all movement commands with position control where no individual deceleration is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 3 (= 0000 0008h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Default value payload (Default value payload)

Param.	PNU: 605		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.1 kg	0	0	200 000	1 kg cm²	0	0	20 000		
Imperial	1 lb	0	0	44 093	0.1 lb in²	0	0	68 343		

This value contains the globally preset payload. This is used in all movement commands where no individual payload is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 5 (= 0000 0020h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Default value position tolerance (Default value tolerance position mode)

Param.	PNU: 606		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.01 mm	100	10	1 000	0.1 °	10	1	100		
Imperial	0.001 in	40	4	394	0.1 °	10	1	100		

This value contains the globally preset tolerance for position control. This is used in all movement commands with position control where no individual tolerance is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 6 (=0000 0040h)

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Default value force tolerance (Default value tolerance force mode)

Param.	PNU: 607		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 N	10	1	1 000		
Imperial	1 lbf	3	1	225		

This value contains the globally preset tolerance for force control. This is used in all movement commands with force control where no individual tolerance is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 7 (=0000 0080h)

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Default value force ramp (Default value force ramp)

Param.	PNU: 608		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 N/s	1 000	10	100 000		
Imperial	1 lbf/s	200	2	22 481		

This value contains the globally preset force ramp. This is used in all movement commands with force control where no individual force ramp is specified (➔ Section 5.3).
PNU 403/521-Bit = bit 8 (=0000 0100h)

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

C.2.11 Drive configuration

The hardware configuration is important for calculating the controller. The data is recognised automatically as much as possible. Data not recognised must be defined by the user, e.g. based on the name plate.

If one of the following values was determined by the automatic hardware recognition, only the value that was stored in the displacement encoder or valve can be written. Writing any other value leads to a parameter error. If no stored value was found for a parameter, parametrising in the specified area is always possible.

For additional information ➔ Appendix B.1.

Cylinder (Cylinder)

Param.	PNU: 1100	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 1		Maximum: 7	

The cylinder type is stored in the displacement encoder or sensor interface. The following types are defined in the CMAX:

Value	**Type**
0	Unkown
1	Rodless linear drive (also for user-defined axis DGPI)
2	Piston rod drive
3	DGCI
4	DNCI
5	DSMI
6	DDPC
7	DDLI

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Cylinder length (Cylinder length)

Param.	PNU: 1101		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01 mm	0	5 000	202 000	0.1 °	0	500	100 000
Imperial	0.01 mm	0	5 000	202 000	0.1 °	0	500	100 000

The cylinder length is stored in the displacement encoder. Standard cylinders are not longer than 2000 mm, the range of values includes reserves for special applications.
The specified cylinder length may deviate from the nominal length by 5.00 mm in order to optimise the effective stroke.
In combination with the DGCI: If an integrated clamping unit is used (order option 1H-PN), the cylinder length is greater than the nominal length. That must be taken into account when specifying the cylinder length ➔ Appendix B.2.5.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Cylinder diameter (Cylinder diameter)

Param.	PNU: 1102		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01 mm	0	1 600	32 000	0.01 mm	0	1 200	32 000
Imperial	0.01 mm	0	1 200	32 000	0.01 mm	0	1 200	32 000

The cylinder diameter is stored in the displacement encoder.
If the cylinder diameter was recognised by CMAX (e.g. during DGCI), the value cannot be overwritten.
Dual axes can be configured through PNU 1143:2 (double-axis design).
Other diameters can only be projected via user-specific cylinder types.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Diameter of piston rod (Piston rod diameter)

Param.	PNU: 1103		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.01 mm	0	0	32 000	0.01 mm	0	0	32 000		
Imperial	0.01 mm	0	0	32 000	0.01 mm	0	0	32 000		

The piston rod diameter cannot be recognised automatically. However, the Festo standard drives have a fixed allocation of cylinder diameters to piston rod diameters. This allocation is stored in the FCT.
With other drives and special applications, the piston rod diameter can be parametrised as required by using the user-defined type.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

DGCI: Integrated clamping unit (DCGI: Integrated clamping unit)

Param.	PNU: 1104	Index: 1	Max. Index: 6	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

With use of a DGCI: The drive is equipped with the integrated clamping unit 1H-PN. This option must also be set for option 1143:3 “clamping unit used”.
The drive is extended by the length of the clamping unit; no stroke reduction takes place. The drive must be familiar with the complete cylinder length so that the controller can work correctly. But the parameter cylinder length (PNU 1101) includes only the nominal length. The CMAX adds for the controller the stroke extension to the cylinder length, which is dependent on the diameter.
Drive option with use of the DGCI ➔ Section B.2.5

Value	Meaning
0	The clamping unit used is not an integrated clamping unit
1	The clamping unit used is the integrated clamping unit (-1H-PN) (parameter 1143:1 = 1, otherwise error E05)

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

DGCI: Additional slide (DGCI: Additional slide)

Param.	PNU: 1104	Index: 2	Max. Index: 6	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 3	

With use of a DGCI: An accompanying additional slide for increasing torques is available. The additional slide reduces the effective stroke. With the help of this parameter, the plug-in calculates the required software end positions so the drive does not run into the stop.
In parameterisation via the controller, the controller programmer must determine the software end positions. Calculation ➔ Section B.2.5.
Recommendation: The calculation should be made through the plug-in and the parameters taken over or exported from there.

Value	Meaning
0	No additional slide
1	Additional slide left (-KL)
2	Additional slide right (-KR)
3	Additional slides, left and right (-KL-KR)

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

DGCI: Lubrication function (DGCI: Lubrication)

Param.	PNU: 1104	Index: 3	Max. Index: 6	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

Value	Meaning

In combination with DGCI and the use of additional slides: The drive has been configured with central lubrication. Central lubrication has an effect on the slide length and must therefore be taken into account in calculating the software end positions. The plug-in takes the specific slide length into account in calculating the software end positions.
In parameterisation via the controller, the controller programmer must determine the software end positions. Calculation ➔ Section B.2.5.
Recommendation: The calculation should be made through the plug-in and the parameters taken over or exported from there.

Value	Meaning
0	Standard
1	Lubrication adapter (-C)

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

DGCI: Slide (DGCI: Slide)

Param.	PNU: 1104	Index: 4	Max. Index: 6	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

In combination with DGCI and additional slide: The drive is equipped with a protected recirculating ball bearing guide.
The protected recirculating ball bearing guide has an effect on the slide length and must therefore be taken into account in calculating the software end positions. The plug-in takes the specific slide length into account in calculating the software end positions
In parameterisation via the controller, the controller programmer must determine the software end positions. Calculation ➔ Section B.2.5.
Recommendation: The calculation should be made through the plug-in and the parameters taken over or exported from there.

Value	Meaning
0	Recirculating ball bearing guide
1	Protected recirculating ball bearing guide (-GP)

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

DGCI: Distance between slide and additional slide KR (DGCI: Distance between slide and additional slide KR)

Param.	PNU: 1104	Index: 5	Max. Index: 6	Class: Struct	Data type: int32

	Linear drive				Semi-rotary drive
	Unit	Specification	Minimum	Maximum	No additional slide is available with semi-rotary drives
Metric	0.01 mm	0	0	202 000	
Imperial	0.001 mm	0	0	759 528	

In combination with the additional slide KR with the DGCI, this value defines the distance between the standard slide and the additional slide KR. With this value, the plug-in calculates the minimum permissible lower software end position, which prevents the slide from running at high speed against the lower stop.
In parameterisation via the controller, the controller programmer must determine the software end positions. Calculation ➔ Section B.2.5.
Recommendation: The calculation should be made through the plug-in and the parameters taken over or exported from there.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

DGCI: Distance between slide and additional slide KL
(DGCI: Distance between slide and additional slide KL)

Param.	PNU: 1104		Index: 6	Max. Index: 6	Class: Struct	Data type: int32
	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	No additional slide is available with semi-rotary drives	
Metric	0.01 mm	0	0	202 000		
Imperial	0.001 mm	0	0	759 528		

In combination with the additional slide KL with the DGCI, this value defines the distance between the standard slide and the additional slide KL. With this value, the plug-in calculates the minimum permissible upper software end position, which prevents the slide from running at high speed against the upper stop.
In parameterisation via the controller, the controller programmer must determine the software end positions. Calculation ➔ Section B.2.5.
Recommendation: The calculation should be made through the plug-in and the parameters taken over or exported from there.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Displacement encoder type (Displacement encoder)

Param.	PNU: 1110	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 1		Maximum: 4	

The measurement system type is read, if possible, from the displacement encoder or sensor interface. If the displacement encoder or sensor interface delivers no known type, an error E04 is reported. The displacement encoder or sensor interface is not commissioned in this case.

ID	Type
0	Unkown
1	Digital – DGCI, DDLI
2	Digital – MME (also for user-defined axis DGPI)
3	Potentiometer
4	Incremental

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Displacement encoder length (Displacement encoder length)

Param.	PNU: 1111		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	0.01 mm	0	5 000	1 000 000	0.1 °	0	500	100 000		
Imperial	0.01 mm	0	5 000	1 000 000	0.1 °	0	500	100 000		

Length of the displacement encoder.

For linear drives with integrated or factory-installed displacement encoders, the cylinder length and displacement encoder length must agree.
In the DGCI, the displacement encoder length is stored in the displacement encoder.

Special case of digital measuring system MME (external or with user-defined drive, e.g. for DGPI):
The internal dimension encoder length must always be 28 mm longer than specified on the rating plate (also, an additional offset axis zero point of 28 mm in PNU 1130 must be taken into account).
During parameterisation with the FCT plug-in, this is automatically calculated correctly and transmitted by the plug-in ➔ Appendix B.2.3.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Displacement encoder serial number (Displacement encoder serial number)

Param.	PNU: 1112	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			

Each displacement encoder or sensor interface has a unique serial number.
The serial number can be used to identify exchanged hardware (➔ Appendix A.3).

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Valve (Valve)

Param.	PNU: 1120	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 1	Maximum: 5		

The valve type is read from the valve. The type is always recognised. If the valve delivers no known type, an error E04 is generated. The valve is not commissioned in this case.

ID	Valve type
0	Not configured
1	Reserved
2	VPWP-4
3	VPWP-6
4	VPWP-8
5	VPWP-10

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Valve serial number (Valve serial number)

Param.	PNU: 1121	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			

Each valve has a unique serial number.
The serial number is important for identifying exchanged hardware (➔ Appendix A.3).

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Valve 2 (Valve 2)

Param.	PNU: 1125	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 1	Maximum: 5		

Reserved

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Valve 2 serial number (Valve 2 serial number)

Param.	PNU: 1126	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000

Reserved

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

C.2.12 Application settings

Offset axis zero point (Offset axis zero point)

Param.	PNU: 1130		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01 mm	0	-1 000 000	1 000 000	0.1 °	100	-100 000	100 000
Imperial	0.001 in	0	-393 701	393 701	0.1 °	100	-100 000	100 000

The difference between the axis zero point (AZ) and the homing position (REF) or the difference between the axis zero point (AZ) and the measuring system zero point (SZ) ➔ Appendix B.2.
The axis zero point must be placed on the cylinder zero point for servo-pneumatic drives. With the DGCI/DDLI, the measuring system is calibrated, and specification of an offset is not permitted.

Special case of digital measuring system MME (external or with user-defined drive, e.g. for DGPI):
An additional offset axis zero point of 28 mm must always be considered (in addition, the internal measurement system length, which must always be 28 mm longer than the specification on the rating plate, must be specified in PNU 1111).
During parameterisation with the FCT plug-in, this is automatically calculated correctly and transmitted by the plug-in ➔ Appendix B.2.3.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Homing method (Homing method)

Param.	PNU: 1131	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: -17	Minimum: -128		Maximum: 127	

Defines the method which the drive uses to carry out the homing section (➔ Section 3.2.2).
Only the named values are permitted.

hex	dec	Description
23 h	35	Current actual position as reference position
EFh	-17	Search for negative stop
EEh	-18	Search for positive stop

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Homing speed (Homing velocity)

Param.	PNU: 1132		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.001 m/s	50	10	200	1 °/s	50	10	200
Imperial	0.01 ft/s	15	3	66	1 °/s	50	10	200

Speed at which the drive searches for the stop during homing.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Homing timeout (Homing timeout)

Param.	PNU: 1133	Index: 1	Max. Index: 1	Class: Var	Data type: int32

Internal parameter.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Homing payload (Homing payload)

Param.	PNU: 1134		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.1 kg	0	0	200 000	1 kg cm^2	0	0	20 000
Imperial	1 lb	0	0	44 093	0.1 lb in^2	0	0	68 343

Consideration of a specific payload in homing.
Only effective if use of the global default value (default value for deceleration, PNU 605) has been deactivated with PNU 521:04.

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Mounting position (Mounting orientation)

Param.	PNU: 1140		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specifi-cation	Minimum	Maximum	Unit	Specifi-cation	Minimum	Maximum
Metric	0.1 °	0	-900	900	0.1 °	0	-900	900
Imperial	0.1 °	0	-900	900	0.1 °	0	-900	900

Mounting position of the drive.

– Linear drives/piston rod drives: A specification of -90° to -0.1° means that the measurement system zero point is on top and the drive moves downward towards larger positions. With values from 0.1 to 90°, the measurement system zero point is underneath and the drive moves to the top.
– Semi-rotary drives:
  – 0°: Shaft points upwards.
  – ±90°: Shaft points in a horizontal direction.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Supply pressure (Supply pressure)

Param.	PNU: 1141		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specifi-cation	Minimum	Maximum	Unit	Specifi-cation	Minimum	Maximum
Metric	0.1 bar	60	30	100	0.1 bar	60	30	100
Imperial	1 psi	85	44	145	1 psi	85	44	145

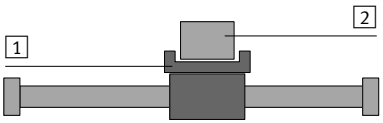
Supply pressure applied to the valve.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Base load (Basic load)

Param.	PNU: 1142		Index: 1		Max. Index: 1		Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.1 kg	50	5	200 000	1 kg cm^2	50	1	20 000
Imperial	1 lb	10	1	44 093	0.1 lb in^2	200	2	68 343

Base load, mass or mass moment of inertia present in all movement commands.



Calculation of the total load:
1 Base load (PNU 1142)
Moved base load, including piston rod, piston, slide as well as the components permanently installed on the slide. This load must always be moved by the drive (minimum load to be moved).
2 Current payload (PNU 605/410/...)
If the drive also has to move workpieces of different weights, this variable share must be defined as payload.

The CMAX calculates the sum of base load and current payload for every positioning process. The respective total load present is determined by specifying the changing payload (PNU 605 is the global default value). During jogging (PNU 536), direct drive (PNU 544 or 551) and homing (PNU 1134), the payload can also be specified individually in each record (PNU 410).

- ☐ The parameter value cannot be changed.
- ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
- ☐ After writing, controller recalculation is carried out.

Payload loaded at power on (Payload at power-on)

Param.	PNU: 1143	Index: 1	Max. Index: 4	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

When the controller is released (drive released), the last valid payload is always used. Usually no workpiece is loaded during the first enable after switch-on, so CMAX only takes into account only the base load (PNU 1142). This parameter defines whether the payload should also be taken into account at switch-on.

Value	Meaning
0	Workpiece not loaded when switching on. The workpiece is only loaded during operation.
1	The workpiece is in the loader during power-on.

Note: With every positioning command either the default value (PNU 605) or the value from the individual parameter (PNU 410, 536, 544 or 551, 1134) in the controller is used for the payload. As soon as the first positioning process has occurred after switch-on, the parameter has no effect any more.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Dual axis design (Dual axis design)

Param.	PNU: 1143	Index: 2	Max. Index: 4	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

Enables configuration of a dual axis.
With a dual axis, two parallel cylinders are mechanically coupled and controlled jointly with a valve in order to generate greater force. The second cylinder has its own measuring system. When this option is set, the larger effective piston surface is automatically calculated by the CMAX and does not need to be entered by the user.
Both cylinders must have the same diameter and the same stroke.

Value	Meaning
0	Design as single axis
1	Design as dual axis

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Clamping unit present (Clamping unit installed)

Param.	PNU: 1143	Index: 3	Max. Index: 4	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

Defines whether or not a clamping unit is installed.
The behaviour of the CMAX depends on the clamping unit. At a start, the clamping units needs to be released, for example, otherwise the CMAX will report an error.
DGCI: If an integrated clamping unit is used (order option 1H-PN), the cylinder length is greater than the nominal length. That must be taken into account when specifying the cylinder length in PNU 1100
➔ Appendix B.2.5.

Value	Meaning
0	Not present
1	Yes

PNU 522 (FHPP settings) determines what effect the control bit CCON.BRAKE has.

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Through piston rod (Through piston rod)

Param.	PNU: 1143	Index: 4	Max. Index: 4	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

Defines whether the piston rod of a piston drive should be double-ended (through) or single-ended.
A through piston rod is customarily used for operating a clamping unit. The controller takes into account the resulting effective piston surface.

Value	Meaning
0	Piston rod at one end
1	Through piston rod

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Response delay E50 (Response delay)					
Param.	PNU: 1144	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	
The response delay for E50 defines the maximum time that the CMAX waits during pressure transfer before it reports an E50 error in case of too little pressure ➔ A.3.7.					

Value	**Maximum time for 1st pressure rise of 100 mbar+**	**Maximum time to reach the minimum pressure**
0	0.1 s (specification)	1.0 s
1	0.5 s	2.0 s
2	1.0 s	5.0 s
3	5.0 s	20.0 s
4	10.0 s	40.0 s
5	20.0 s	100.0 s
6	30.0 s	300.0 s

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

C.2.13 Position controller

Position controller amplification gain (Position control gain factor)

Param.	PNU: 1150		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01	100	10	1 000	0.01	100	10	1 000
Imperial	0.01	100	10	1 000	0.01	100	10	1 000

Position controller amplification gain ➔ Appendix B.5.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Position controller cushioning factor (Position control damping factor)

Param.	PNU: 1151		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01	100	10	1 000	0.01	100	10	1 000
Imperial	0.01	100	10	1 000	0.01	100	10	1 000

Position controller cushioning factor ➔ Appendix B.5.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Position controller filter factor (Position control filter factor)

Param.	PNU: 1152		Index: 1	Max. Index: 1		Class: Var		Data type: int32
Values	Linear drive				Semi-rotary drive			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01	100	10	1 000	0.01	100	10	1 000
Imperial	0.01	100	10	1 000	0.01	100	10	1 000

Position control filter factor ➔ Appendix B.5.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Position controller timeout (Position control timeout)

Param.	PNU: 1153		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	1 ms	2 000	0	100 000	1 ms	2 000	0	100 000		
Imperial	1 ms	2 000	0	100 000	1 ms	2 000	0	100 000		

The positioning timeout defines the time in which the actual position must reach the target value.
The absolute positioning time depends on stroke, setpoint acceleration and setpoint speed. Therefore, the monitoring time cannot monitor the duration of the entire movement command. Instead, the behaviour at the start and end of the setpoint curve is monitored.

– After the start of the setpoint curve, the axis must have moved by at least 11 mm within the timeout time, or the CMAX reports error E31 (no movement after start)
– After the end of the setpoint curve, the actual position must have reached the target position window (and with exact compliance with the speed condition), or the CMAX reports error E30 (timeout: target value not reached)

Note:

Deactivating the positioning timeout parameter can result in a record not being completed with MC and remaining permanently active, for example:

– if the drive comes to a halt before its setpoint position (due to an obstacle),
– if the drive does not reach its setpoint position (depends on specified tolerance).

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Position controller cushioning time for exact stop
(Position Control monitoring time for exact stop)

Param.	PNU: 1154		Index: 1		Max. Index: 1		Class: Var		Data type: int32	
Values	Linear drive				Semi-rotary drive					
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum		
Metric	1 ms	30	10	1 000	1 ms	30	10	1 000		
Imperial	1 ms	30	10	1 000	1 ms	30	10	1 000		

This is the duration in which the actual value must remain in the tolerance window without interruption before MC is generated. Only effective with exact stop; without function with fast stop
➔ Section 3.1.6.
If the time is too short, an overswing may lead to MC, but the actual position may leave the tolerance again. If the time is too long, the positioning time is unnecessarily prolonged. With larger drives, we recommend selecting a longer time.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Deactivate standstill control (Deactivate Standstill Control)					
Param.	PNU: 1155	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	
This parameter determines whether or not standstill control is activated between the positioning positioning procedures.					
Value	**Meaning**				
0	Standstill control is activated during standstill				
1	Standstill control is never activated				
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☒ After writing, controller recalculation is carried out.					

C.2.14 Force controller

Force controller amplification gain (Force control gain factor)

Param.	PNU: 1160		Index: 1	Max. Index: 1		Class: Var	Data type: int32	
Values	Linear drive				Semi-rotary drive[1]			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01	100	10	1 000	0.01	100	10	1 000
Imperial	0.01	100	10	1 000	0.01	100	10	1 000

Force controller amplification gain ➔ Appendix B.5.3.

1) Force control is not permissible with semi-rotary drives. However, the parameter is used for standstill control.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Force controller dynamic amplification (Force control dynamic gain)

Param.	PNU: 1161		Index: 1	Max. Index: 1		Class: Var	Data type: int32	
Values	Linear drive				Semi-rotary drive[1]			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01	100	10	1 000	0.01	100	10	1 000
Imperial	0.01	100	10	1 000	0.01	100	10	1 000

Force controller dynamic amplification ➔ Appendix B.5.3.

1) Force control is not permissible with semi-rotary drives. However, the parameter is used for standstill control.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Force control filter factor (Force control filter factor)

Param.	PNU: 1162		Index: 1	Max. Index: 1		Class: Var	Data type: int32	
Values	Linear drive				Semi-rotary drive[1]			
	Unit	Specification	Minimum	Maximum	Unit	Specification	Minimum	Maximum
Metric	0.01	100	10	1 000	0.01	100	10	1 000
Imperial	0.01	100	10	1 000	0.01	100	10	1 000

Force control filter factor ➔ Appendix B.5.3.

1) Force control is not permissible with semi-rotary drives. However, the parameter is used for standstill control.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Force controller timeout (Force control timeout)

Param.	PNU: 1163		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 ms	2 000	0	100 000		
Imperial	1 ms	2 000	0	100 000		

Time within which the actual force must reach the tolerance window after the force ramp has reached the target value. This means, the time starts when setpoint value generation has elapsed.
If the time is set to 0, no monitoring is carried out.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Force controller monitoring time for exact stop (Force control monitoring time for exact stop)

Param.	PNU: 1164		Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Linear drive				Semi-rotary drive	
	Unit	Specification	Minimum	Maximum	Force control is not permissible with semi-rotary drives.	
Metric	1 ms	100	10	1 000		
Imperial	1 ms	100	10	1 000		

This is the duration in which the actual value must remain in the tolerance window without interruption before MC is generated. Only effective with exact stop; without function with fast stop
➔ Section 3.1.6.
If the time is too short, an overswing may lead to MC, but the actual force may leave the tolerance again. If the time is too long, the positioning time is unnecessarily prolonged. With larger drives, we recommend selecting a longer time.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

C.2.15 Identification

Identification settings (Identification settings)					
Param.	PNU: 1170	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	
The parameter allows you to make certain settings that concern identification.					
= 0:	In identification, high acceleration is permissible				
= 1:	Only perform the static identification (low acceleration)				
☐ The parameter value cannot be changed.					
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☒ After writing, controller recalculation is carried out.					

Identification status (Identification status)					
Param.	PNU: 1171	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			
Current status according to the identification carried out last.					

Bit	**Value**	**Description**
0	= 0:	Identification has not yet been executed.
	= 1:	Identification has been executed at least once.
1	= 0:	Static identification results not available.
	= 1:	Static identification carried out successfully.
2	= 0:	Dynamic identification results are not available.
	= 1:	Dynamic identification carried out successfully.
☒ The parameter value cannot be changed.		
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.		
☐ After writing, controller recalculation is carried out.		

Identified average values (Identified average values)					
Param.	PNU: 1172	Index: 1	Max. Index: 6	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Average values for the free profile determined during identification.					

Index	**Value**	**Travel direction**
1	Acceleration	Positive
2	Deceleration	Positive
3	Reserved	–
4	Acceleration	Negative
5	Deceleration	Negative
6	Reserved	–
☒ The parameter value cannot be changed.		
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.		
☐ After writing, controller recalculation is carried out.		

Limiting values (Limit values)					
Param.	PNU: 1173	Index: 1	Max. Index: 14	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Information about limiting in the positioning stroke last executed ➔ Section 3.1.10.					

Index	**Value**
1	Status word[1)]
2	Start position (actual value)
3	Target position
4	Setpoint acceleration
5	Maximum value of acceleration
6	Setpoint deceleration
7	Maximum deceleration value
8	Setpoint speed
9	Maximum value speed
10	Setpoint force
11	Maximum force value
12	Force ramp setpoint value
13	Force ramp maximum value
14	Starting force

Allocation of status word (Index 1)

Bit	**Status information**	
0	= 1:	New values are now available
1	= 1:	Acceleration has been limited
2	= 1:	Deceleration has been limited
3	= 1:	Speed has been limited
4	= 1:	Force setpoint value has been limited
5	= 1:	Force ramp has been limited
6 ... 15	Reserved	
16 ... 23	For record mode: Number of the record executed last.	
24	= 0:	Record mode
	= 1:	Direct mode
25	= 0:	Position setpoint value
	= 1:	Force setpoint value
26	= 0:	Free profile
	= 1:	Automatic profile
27 ... 31	Reserved	

1) The status word is used as a handshake between CMAX and FCT. As soon as the bit 0 is set by the controller, the data are no longer overwritten. In this way the FCT can consistently read the data. After reading, FCT writes a 0 into the status word as confirmation, and the controller updates the values. The status word (index 1) may be written by the FCT without higher-order controller. It is also not necessary to enter a password.

☒ The parameter value cannot be changed (except Index 1).

☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.

☐ After writing, controller recalculation is carried out.

Status of movement test (Status movement test)

Param.	PNU: 1174	Index: 1	Max. Index: 1	Class: Var	Data type: bit array
Values	Specification:	0000 0000	0000 0000	0000 0000	0000 0000
	Write:	-			

Current status of the movement test.

Bit	Value	Description
0	= 0:	Movement test must be carried out.
	= 1:	Movement test does not have to be carried out.
1	= 0:	Movement test was not carried out
	= 1:	Movement test was carried out
2	= 0:	Result of the movement test is not clear
	= 1:	Result of the movement test is clear
3	= 0:	Tubing connection error
	= 1:	Tubing connection OK
4	= 0:	Movement test was not skipped
	= 1:	Movement test was skipped
5	= 0:	No hardware exchange
	= 1:	Movement test has been reset after hardware exchange

Information on the movement test ➔ Section 3.2.1.

As long as the movement test has to be carried out (bit 0 = 0), the controller is not enabled. With SCON.ENABLED = 1, movement enable is available only for the movement test; the valve is only operated if it is controlled.

With a starting edge for a movement command other than the movement test, the error E14 “Movement test not executed” is issued.

FCT indicates the status “Movement test” in the “Extended data” frame. The LED turns green when the parameter value has the status xxx0 1111_b.

If the hardware was exchanged, the movement test is automatically reset by the CMAX. This is not reversible. Example: Exchange valve and change it back again.

With PNU 1192:07, the movement test can be skipped or the status reset.

☒ The parameter value cannot be changed.

☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.

☐ After writing, controller recalculation is carried out.

Block adaptation (Disable adaptation)

Param.	PNU: 1175	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

This parameter is used to deactivate adaptation. This is practically not required in any configuration; only in extremely rare cases does adaptation worsen the positioning behaviour. In most case adaptation is useful. Adaptation improves the absolute precision reachable by the drive.
Worsening of the positioning behaviour is not always caused by faulty adaptation ➔ Section 3.2.4.

Values:

= 0:	Adaptation is performed
= 1:	Adaptation is blocked

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Offset and hysteresis values of the drive (Offset and hysteresis values of the drive)

Param.	PNU: 1176	Index: 1	Max. Index: 16	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

Internal parameter.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

C.2.16 System data

Hardware actual configuration (Actual hardware configuration)					
Param.	PNU: 1190	Index: 1	Max. Index: 33	Class: Struct	Data type: int32/bit array
Values	Specification: 0	Minimum: -	Maximum: -		
Hardware configuration found at switch-on (actual configuration). Value 0 means that the parameter could not be recognised automatically. For comparison, the corresponding PNUs of the setpoint configuration are listed here as well.					
Index	**Value**	**Value of the setpoint configuration**			
Cylinder					
1	Cylinder type	PNU 1100			
2	Tubing length	PNU 1101			
3	Diameter	PNU 1102			
4	Piston rod diameter	PNU 1103			
5	Length	PNU 1101			
6 ... 9	Reserved	–			
Displacement encoder					
10	Displacement encoder type	PNU 1110			
11	Length	PNU 1111			
12	Serial number	PNU 1112			
13	Resolution (µm)	–			
14	Sampling time (µs)	–			
15	Additional information ➔ Section B.2.5	–			
16	Firmware version	–			
17 ... 19	Reserved	–			
Valve					
20	Valve type	PNU 1120			
21	Serial number	PNU 1121			
22	Firmware version	–			
23	Hardware Version:	–			
24 ... 33	Reserved	–			
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Notes on PNU 1190:

- **Behaviour on delivery or after resetting the axis or device data:** The recognised configuration is not automatically included in the setpoint configuration. Instead the setpoint configuration is filled with 0. The setpoint configuration must be written compatible to the actual configuration.
- **Behaviour at standard start:** If the recognised hardware does not correspond to the setpoint configuration, this will trigger error handling. A decision is made whether the change must lead to a warning or an error. In certain cases, the controller is not activated.
- If an identification is performed successfully, the serial numbers are adopted so that the warning W08 (cylinder, valve or sensor interface were exchanged) is no longer issued the next time the device is switched on.
- The piston rod diameter is not provided by the sensor interface. The actual configuration always contains the value 0. However, since this is a valid value for rodless drives, the value 0 is not considered “not recognised” in the case of the piston rod diameter. Therefore, no check of setpoint and actual configuration is made after switch-on.

Analysis data (Analysis data)

Param.	PNU: 1191	Index: 1	Max. Index: 15	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Internal data for controller qualification.					
☒ The parameter value cannot be changed.					
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.					
☐ After writing, controller recalculation is carried out.					

Commissioning operation block download (Commissioning function block download)

Param.	PNU: 1192	Index: 1	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 1	

After writing a parameter, controller initialisation is carried out. During this, a check is made whether certain parameters fit together, e.g. whether the lower software end position is smaller than the upper software end position. If an error is detected, an error message is generated and the CMAX changes to “error” status.
Activating block download can temporarily deactivate these tests. The controller only checks the data when the block download has finished.

Writing		**Reading**	
= 1:	Start block download	= 1:	Block download active
= 0:	End block download	= 0:	Block download not active

The controller is only recalculated after writing block download = 0 (end block download). The controller should be deactivated during block download.
While block download is active, start cannot be executed. Activating the block download is ended at the latest when switching off the CMAX. In this case, controller recalculation is carried next time the CMAX is switched on.

☐ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Commissioning operation configuration status (Commissioning Function configuration status)

Param.	PNU: 1192	Index: 2	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 4	

When commissioning a certain number of parameters must be transmitted in a certain order. This parameter provides information about the status of parameterisation and about the next commissioning step to be performed.

Possible return values		**Display**
= 0:	Wait for system of measurement units	C00
= 1:	Wait for cylinder type	C01
= 2:	Wait for axis data	C02
= 3:	Wait for movement test	C03
= 4:	Axis configuration completed	Dependent on the respective operating status

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Commissioning operation data reset (Commissioning function data reset)					
Param.	PNU: 1192	Index: 3	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 3	
A data reset is used to reset some or all parameters of the CMAX to the factory settings. That always makes sense if parts of the drive or system have changed and the configuration must be adjusted. Various resets make sense, depending on the extent of the change.					
= 0:	No effect				
= 1:	Reserved				
= 2:	Delete identification data				
= 3:	Delete axis data and identification data				
Additional information: ➔ A.3.3 Change reference configuration ➔ A.3.4 Data reset					
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☒ After writing, controller recalculation is carried out.					

Commissioning operation password status (Commissioning function password status)					
Param.	PNU: 1192	Index: 4	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2	
PNU 130 contains a password. The parameter PNU 1192:04 controls the acceptance and delivers the current status.					
Writing		**Reading**			
= 0:	Deleting a password	= 0:	No password set		
= 1:	Accept password	= 1:	Password set and access free		
		= 2:	Password set and access blocked		
After acceptance the password needs to be entered each time a connection is established via the diagnostic interface in order to change parameters. Procedure: 1. Write PNU 130: = “My_password” 2. Write PNU 1192:04 = 1 for acceptance To change it, first enter the old password and then delete it. Then the new password can be entered and accepted.					
☐ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Commissioning operation measurement system
(Commissioning function system of measurement)

Param.	PNU: 1192	Index: 5	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2	

The system of measurement must be defined prior to parameterisation. The metric or imperial system of measurement is selected.
No parameter from PNU 300 onwards can be read or written as long as this index has the value 0 and the table for the system of measurement is not defined.

Writing		**Reading**	
= 0:	Not permissible	= 0:	Not configured
= 1:	Metric / SI	= 1:	Metric / SI
= 2:	Imperial / US	= 2:	Imperial / US

Switching the system of measurement (1 to 2 or 2 to 1) is not possible. A changeover requires performing an axis data reset first (PNU 1192:03).

☐ The parameter value cannot be changed.
☒ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☒ After writing, controller recalculation is carried out.

Commissioning function system of measurement units table
(Commissioning function system of measurement table)

Param.	PNU: 1192	Index: 6	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 4	

The system of measurement units table corresponds to the selected table in accordance with ➔ Appendix B.1. The table contains the unit (millimetre or inch) used for every dimension and the scaling. The system of measurement table is derived from the system of units and the cylinder type.
No parameter from PNU 300 onwards can be read or written as long as this index has the value 0 and the table for the system of measurement is not defined.

Read:	
= 0:	Not configured
= 1:	Metric / linear ➔ Appendix B.1.1, Tab. B.2
= 2:	Imperial / linear ➔ Appendix B.1.1, Tab. B.4
= 3:	Metric / rotative ➔ Appendix B.1.1, Tab. B.3
= 4:	Imperial / rotative ➔ Appendix B.1.1, Tab. B.5

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Commissioning function movement test status (Commissioning function movement test status)					
Param.	PNU: 1192	Index: 7	Max. Index: 7	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: 0		Maximum: 2	
Define status of the movement test.					
Write:					
= 1:	Movement test is reset and must be carried out again				
= 2:	Movement test is set to “does not have to be carried out” and is skipped				
Read:					
= 0:	Movement test does not have to be carried out.				
= 1:	Movement test must be carried out.				
Note: PNU 1174:01 contains the bit-coded status of the movement test with the details (skipped, executed, etc.). This parameter 1192:07 is designed as a possibility for resetting and skipping the movement test and modifies the PNU 1174:01 during writing.					
☐ The parameter value cannot be changed. ☒ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☒ After writing, controller recalculation is carried out.					

System of measurement units (System of measurement units)					
Param.	PNU: 1193	Index: 1 ... 12	Max. Index: 12	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Determines physical units ➔ Appendix B.1.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

System of measurement units resolution (System of measurement resolution)					
Param.	PNU: 1194	Index: 1 ... 12	Max. Index: 12	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	
Determines the scaling/resolution or number of decimal places ➔ Appendix B.1.					
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

Start configuration (Start configuration)

Param.	PNU: 1195	Index: 1 ... 5	Max. Index: 5	Class: Struct	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

The start configuration includes important configuration data at the time of identification. After identification, the current configuration may only be modified within certain limits. If the setpoint configuration is to be changed outside of these limits, the identification data must first be deleted. After adjustment of the setpoint configuration, a new identification must be carried out.
Exchange of a component is recognised through the new serial number. The CMAX then generates warning W08. Identification must be executed. The new serial number is then transferred automatically.

Index	Value	Setpoint configuration	Tolerance
1	Cylinder length	PNU 1101	5.00 mm
2	Displacement encoder length	PNU 1111	5.00 mm
3	Reserved	–	–
4	Mounting position	PNU 1140	3°
5	Supply pressure	PNU 1141	1 bar
6	Serial number of displacement encoder	PNU 1112	–
7	Serial number of valve	PNU 1121	–

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Trace configuration: maximum supported version (Trace configuration: max. supported version)

Param.	PNU: 1198	Index: 1	Max. Index: 1	Class: Var	Data type: int32
Values	Specification: 4	Minimum: -		Maximum: -	

Parameter for the FCT.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

Production parameters (Manfacturing data)

Param.	PNU: 1199	Index: 1 ... 7	Max. Index: 7	Class: array	Data type: int32
Values	Specification: 0	Minimum: -		Maximum: -	

Internal parameter.

☒ The parameter value cannot be changed.
☐ Writing permissible only in commissioning/parameterisation mode with blocked drive.
☐ After writing, controller recalculation is carried out.

C.2.17 Error texts

Error text E... (Errortext E...)					
Param.	PNU: 2100 ... 2189	Index: 1 ... 81	Max. Index: 81	Class: array	Data type: char
Values	Specification:	Respective text of the error or warning			
	Permissible characters:	0x00, 0x20 ... 0xFF (printable ASCII characters)			
	Impermissible characters:	0x01 ... 0x19 (control character)			
Reading error and warning texts. The output language is determined with PNU 154. With undefined errors, “Unknown error” (“Unknown Error”) is output. The controller can read the texts by character up to the closing character 0x00. An error text can thus be a maximum of 80 characters long.					
PNU	**Name**	**Value (for PNU 154 = 0: English)**			
2100	Error text E00	“No Error”			
2101	Error text E01	“The nominal configuration deviates from actual configuration”			
...	Error text E...	“...”			
2189	Error text E89	“Faulty data contents in the displacement encoder or sensor interface”			
☒ The parameter value cannot be changed. ☐ Writing permissible only in commissioning/parameterisation mode with blocked drive. ☐ After writing, controller recalculation is carried out.					

D Glossary

The following product-specific terms and abbreviations are used in this manual:

Term/abbreviation	Significance
0xA0 ($A0_h$)	Hexadecimal numbers are indicated by a prefixed “0x” or by a subscript “h”.
Absolute position measuring system	Displacement encoder with a fixed (absolute) assignment of measured value (position, angle, ...) and measured variable, for “digital” or “potentiometer” CMAX.
Adaptation	CMAX function for automatically improving non-optimal control behaviour during operation.
Axis string	Totality of all modules and cables which are connected to the CMAX via the axis interface.
Bus nodes	Provide the connection to specific fieldbuses. Transmit control signals to the connected modules and monitor their functioning (here as CPX module).
CPX modules	Collective term for the various modules which can be integrated into a CPX terminal.
CPX terminal	Complete system consisting of CPX modules with or without pneumatics.
Drive	In this description, the term “drive” represents the terms linear drive (DGCI, DDLI, DGP), standard cylinder or positioning drive (DNC, DNCI, DDPC, DNCM) or semi-rotary drive (DSMI).
Festo Configuration Tool (FCT)	Software with standardised project and data management for supported device types. The special requirements of a device type are supported with the necessary descriptions and dialogues by means of plug-ins.
Festo Handling and Positioning Profile (FHPP)	Device and communication profile for position controllers from Festo.
Festo Parameter Channel (FPC)	FHPP-specific parameter access
Functions	Special functions in the different operation modes (e.g. jog operation, homing, ...).
Homing	Homing defines the homing position and thereby the origin of the measuring reference system of the axis.
I	Digital input. From the point of view of the higher-order controller, the CMAX status inputs are module input data (➔ Section 2.2).
I/Os	Digital inputs and outputs
Identification	System function where specific characteristics of the connected axis can be determined by means of an identification run, e.g. the break-away forces, friction behaviour, dynamics (maximum accelerations and speeds), etc.

Term/abbreviation	Significance
Incremental displacement encoder	A displacement encoder in which the measurement variable refers to a reference point and is determined by counting equally large measurement steps (increments).
Jog operation	Manual travel in a positive or negative direction. Function for setting positions by approaching the target position, e.g. for teaching records.
Logic 0	Input or output provides 0 V (also LOW, FALSE or 0-signal).
Logic 1	Input or output provides 24 V (also HIGH, TRUE or 1-signal).
O	Digital output. From the point of view of the higher-order controller, the CMAX control inputs are module output data (➔ Section 2.2).
OB	Output byte
Operating mode	Type of CMAX control, function or setpoint specification.
Parameters	Different settings which are defined for the system operation and have to be saved in the CMAX.
PNU	Parameter number; each parameter has a number and subindex (➔ Chapter C). Notation: PNU xxxx:zz (xxxx:parameter number, zz: subindex).
Position control	Control mode where a defined position is approached and stopped at under electronic control.
Pressure/force control	Control mode for which a defined force is built up via pressure control. In the following, the term “force control” is always used.
Project zero point (PZ)	Measuring reference point for all positions in positioning commands (project zero point). The project zero point forms the basis for all absolute position specifications (e.g. in the record table or in direct mode). The point of reference for the project zero point is the axis zero point.
Record	Positioning command defined in the record table, consisting of target position, positioning mode, speed, acceleration, ...
Reference point (REF)	Point of reference for the incremental displacement encoder. The reference point defines a known orientation or position within the travel path of the drive.
Software end position	Programmable stroke limit (point of reference = axis zero point) **Upper software end position:** Max. limit position in the positive direction (increasing actual values). **Lower software end position:** Min. limit position in the negative direction (decreasing actual values).

Tab. D.1 Terms and abbreviations

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